EOS GROUND SYSTEM (EGS)
TEST VERSION INTERFACES
TECHNICAL ANALYSIS REPORT (TAR)

Draft
(Deliverable 0903)

July 7, 1995

Prepared by:

INTERMETRICS
6301 Ivy Lane
Greenbelt, MD 20770

Prepared for:

NASA Goddard Space Flight Center
Code 505
Greenbelt, MD 20770

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PREPARED BY:

Katherine R. Murphy
Technical Lead

PREPARED BY:

Michael Blazejewski
Task Member

PREPARED BY:

Michael Eastman
Task Member

PREPARED BY:

Susan Imhoff
Task Member

PREPARED BY:

Monica Rankin
Task Member

PREPARED BY:

Diane Womack
Task Member

REVIEWED BY:

Peter Van Wie
Task Leader

APPROVED BY:

Ron Cariola
Program Manager

RECEIVED BY:

Lee LaCoste Document
Log Manager

INTERMETRICS
6301 Ivy Lane
Greenbelt, MD 20770

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1. EXECUTIVE SUMMARY

This technical analysis report (TAR) documents the results of the Independent Verification and Validation (IV &V) Interface Analysis for the Earth Observing System (EOS) Ground System (EGS) Test Version. The EGS Test Version release interfaces are identified as:

1.	ECS-NISS	Earth Observing System Data and Information System (EOSDIS) Core System (ECS) to NASA Institutional Support Systems, documented in the Interface Requirements Document (IRD) Between ECS and NASA Institutional Support Systems (NISS)	10/94	194-219-SE1-020
2.	ECS-NSI	ECS to NASA Science Internet, documented in the Interface Requirements Document Between ECS and NASA Science Internet (NSI)	10/94	194-219-SE1-001
3.	ECS-SCF	ECS to Science Computing Facilities, documented in the Interface Requirements Document Between ECS and Science Computing Facilities (SCF)	06/94	194-219-SE1-05
4.	ECS-TRMM	ECS to Tropical Rainfall Measuring Mission (TRMM) Interface, documented in the Interface Requirements Document Between EOSDIS and the TRMM Ground System	02/95	194-219-SE1-018

A requirements analysis was conducted to evaluate the technical integrity of the requirements, as described in section 3.2.1 of the Independent System Verification and Validation Plan (ISVVP) [Ref 11]. A data flow analysis was performed following the methods described in section 3.3.1 of the ISVVP. A summary description of the methodology is provided in section 3 of this report.

Problems discovered during the interface requirements analyses are summarized in the table below. Detailed descriptions of these problems are provided in Appendices A, B, C and D.

Interface	# Requirements	Quality	Testability	Traceability	Total Problems
ECS-NISS	34	0	31	10	41
ECS-NSI	8	8	6	2	16
ECS-SCF	41	42	3	19	64
ECS-TRMM	95	7	5	30	40
Total	**178**	**57**	**45**	**61**	**161**

EXHIBIT 1-1: Summary Table of Interface Problem Areas

The key findings of the analysis are provided below, listed in order of importance.

- **The Interface Requirements Documents are not ready to support systems design**

The detailed analysis, presented in the appendices, revealed that there are many technical problems in the IRDs. While most of these problems are not severe by themselves, the number of problems uncovered indicates that there is much detail work to be done by the development teams before high quality Interface Control Documents (ICDs) can be derived from the IRDs. The IRDs have incomplete specification of data volumes, data rates, duty cycles, and related performance requirements. Performance requirements must be defined prior to making interface design trade offs. The ECS Functional and Performance Requirements (F&PR) contains data volume information for many of the data flows, but it is based on an old system architecture. If this information is being maintained in the EOSDIS data model, it is not propagating to the IRDs.

- **A Project-wide Data Dictionary is needed**

A data dictionary is not being used by the developers of the IRDs to ensure consistent naming of data items and data flows. This becomes a problem when comparing the IRDs to external documents. When comparing documents, it is difficult to differentiate the real inconsistencies from the simple naming problems.

- **The RTM data base is not current**

The integrity of the Requirements & Traceability Management (RTM) [Ref 20] database is questionable. The RTM has no ECS-NSI IRD requirements and is missing 21 ECS-TRMM IRD requirements. The RTM contains four requirements that were deleted from the ECS-TRMM IRD prior to baselining. The ECS-NISS and ECS-SCF IRDs have linkages to parent requirements in the IRD traceability matrices that are not documented in the RTM. These RTM observations are based on the 6/15/95 version of RTM.

- **The ICD development schedule is not realistic**

The ICD development does not allow for the incorporation of changes resulting from the IRD updates. Many of the IRDs are still undergoing the ESDIS baselining process, and thus changes would not be available to propogate to the ICDs until they are approved at the IRD level.

- **Parent documents have not been baselined**

The Architecture Description Document (ADD) [Ref 21] and Ground System Architecture Diagram (GSAD) [Ref 22] are not baselined. Since these documents establish the top level architecture of the EGS and the EOSDIS, it is essential that they be baselined to formally establish a starting point for EOSDIS component development. Current development, including interface specification, has been proceeding at risk. Substantial changes to the ADD and GSAD before a baseline is established could lead to the need to drastically re-direct component development without the benefit of a formal Configuration Control Board (CCB) review process.

- **The ECS - NSI Interface Requirements Document is improperly focused**

The ECS - NSI IRD emphasizes network management issues rather than functional and performance requirements. From a technical standpoint, the interface functional and perfomance requirements are insufficiently defined to allow the development of an ICD.

- **The ECS - NSI IRD has not been baselined.**

Development of this interface has been proceeding at risk. Substantial changes to the ECS - NSI IRD before a baseline is established could lead to the need to drastically re-direct interface development without the benefit of a formal CCB review.

- **The current IRDs do not support the decision to combine Ecom and ESN into EBnet**

The IRDs do not support the new network architecture changes. The decision to consolidate EOS Communications (Ecom) and EOSDIS Science Network (ESN) into EOS Backbone Network (EBnet) has rendered some of the current IRDs out of date. This issue is currently under review by the Network Team, but if EBnet interface requirements are not solidified soon, development schedules will suffer.

- **There is not a standard format and content for Interface Requirements Documents**

The Data Item Description (DID) specified for IRDs (DID 219/SE1) is woefully inadequate. The developer is not following any other standard for IRD format and content, leading to widely varying presentation formats and levels of detail in the IRDs. This makes it difficult to review these documents and to check for consistent data descriptions when data flows traverse more than one interface.

The primary recommendations of our analysis are listed below. Complete details for each of these recommendations can be found in section 5.

- Establish a recovery plan for the test version IRDs
- Establish and use an EOSDIS Project Data Dictionary
- Correct the RTM data base deficiencies and review the process for maintaining the RTM data base
- Revise the ICD development schedule to allow necessary corrections made to the IRDs to be incorporated.
- Baseline the EOSDIS ADD and ESDIS GSAD
- Re-write the ECS - NSI IRD to focus on technical issues
- Baseline the ECS - NSI IRD
- Revise the IRDs to support EBnet
- Establish a standard format and content for IRDs and ICDs

2. INTRODUCTION

2.1 PURPOSE

The purpose of this report is to formally document the IV&V analysis of the IRDs for interfaces included in the EGS Test Version. These interfaces are ECS to TRMM, ECS to NISS, ECS to NSI, and ECS to SCF. IRDs are analyzed prior to baselining to provide early feedback to IRD authors, ESDIS Book Bosses and Interface Control Working Group (ICWG) members. This feedback has been provided in the form of IV&V Technical Analysis Memoranda (TAMs).

This report describes the methods used for the EGS Test Version IRD analysis and the automated tools used to facilitate analysis efforts. It provides the results, conclusions, and recommendations obtained from the analysis.

2.2 OBJECTIVES OF THE ANALYSIS

The objective of this analysis is to evaluate the interface requirements and data flows. The intent of interface analysis is to identify potential problem areas early in the system life cycle, thereby reducing the level of effort and expense required to correct these problems, and to lay the ground work for interface test planning. This document identifies problem areas that need correction, assesses the potential impact if the problems are not corrected, and recommends a course of action to correct the problems.

The interface analysis verified:

- Completeness, consistency, and correctness of the interfaces
- Correct and complete specification of functional and performance interface requirements

2.3 SCOPE OF THE ANALYSIS

This report focuses on the analysis performed on the interfaces between the ECS and other elements supporting the EGS test version. These interfaces are listed in Section 1, Executive Summary. These IRDs are not EGS version specific. They are written to reflect the final implementation of the EGS. Only portions of these IRDs will be implemented in the EGS Test Version. This report, and the IV&V IRD analysis has been done on their full content, not just the EGS Test Version portions.

2.4 BACKGROUND INFORMATION

The IRD between the ECS and NISS defines the ECS system requirements for interacting with NASA institutional capabilities that will support mission operations for the various NASA EOS missions. The institutional support systems include the Network Control Center (NCC), the Tracking & Data Relay Satellite System (TDRSS), the Ground Network (GN), the Deep Space Network (DSN), the Wallops Orbital Tracking Station (WOTS), the Flight Dynamics Facility (FDF), and the NASA

Communications (Nascom) Operational Local Area Network (NOLAN). The NCC, TDRSS, GN, DSN, and WOTS systems will provide tracking, telemetry, and command support for EOS spacecraft. The FDF will provide spacecraft orbit and attitude support for flight operations and science data processing. The NOLAN will be used for certain missions to transport science and ancillary data from NASA data processing facilities to the ECS science data processing systems. Specific NISS requirements for interacting with the ECS are not contained within the IRD; they will be defined in the Detailed Mission Requirements (DMR) documents for each EOS mission.

The NSI is an open, international computer network that serves the NASA science and research community. NSI will provide effective network communications between and among EOS researchers, EOS facilities, and the general science community. The NSI connects almost 200 sites worldwide. The NSI is managed by the Network Operations Center (NOC), which monitors the network 24 hours/day, 7 days/week. The NOC coordinates with other network provider NOCs to identify any circuit problems and resolve them in a timely manner. Information is transmitted between ECS and NSI to enable network communications and network management. Data to cooperatively provide services such as fault management, security management, and performance management will be shared between NSI and ECS. The ECS-NSI IRD formalizes the interpretation and general understandings of the interface between ECS and NSI.

SCFs are computing facilities that EOS-funded science investigators use at their home institutions to develop and maintain standard and special product data production software (PDPS), perform quality assurance, order reprocessing of data, request production status and history files, request resource usage updates, administrate and manage local databases, and update coefficients. The SCFs, operated by the investigators, host ECS-supplied software for a variety of scientific activities and for interfacing with the ECS. This software provides a uniform interface to all SCFs and facilitates easy and direct communication between the investigator and ECS. This access allows investigators to:

- Have standard products processed and reprocessed using the ECS production resources;
- Access data products for the purpose of standard and special product data production software development. These data products may reside at archival facilities internal to ECS, or at facilities external to, but accessible by ECS;
- Deliver data production software and special product data for archiving;

- Update calibration coefficients and data production software used in standard product processing; and
- Conduct quality assurance of data products.

TRMM is a Mission to Planet Earth mission designed to advance the understanding of total rainfall and to determine the rate and total amount of rainfall occurring over the tropics and subtropics. TRMM will also carry two instruments designed to facilitate the measurement and analysis of the Earth's radiant energy budget and lightning and thunderstorm activity. The TRMM observatory is scheduled to be launched from Japan in August 1997 and will carry the following instruments:

- Visible Infrared Scanner (VIRS)
- TRMM Microwave Imager (TMI)
- Precipitation Radar (PR)
- Lightning Imaging Sensor (LIS)
- Clouds and Earth's Radiant Energy System (CERES)

The TRMM Ground System consists of the TRMM Science Data and Information System (TSDIS) and three Distributed Active Archive Centers (DAACs). Marshall Space Flight Center (MSFC), Langley Research Center (LaRC), and the Goddard Space Flight Center (GSFC). TSDIS is responsible for the generation of TRMM standard data products, Level 1A-3 PR, TMI, VIRS and Ground Validation (GV). MSFC is responsible for the higher level product generation, data archive and data distribution for LIS data products. Additional responsibilities include the archive and distribution of TMI, PR and GV data. LaRC is responsible for the generation and archival of CERES higher level data products. Finally, GSFC is responsible for the archival and distribution functions for the VIRS data products.

For the TRMM mission, EOSDIS provides a data archive for TRMM science data products, metadata, browse images, science algorithms, associated data and documentation. ECS provides TRMM with non-TRMM ancillary and correlative data and TRMM science data for reprocessing. The ECS provides a user interface to EOSDIS data. ECS also provides access to information that is archived externally to EOSDIS, for systems which have EOSDIS interfaces. ECS accepts user orders for EOS data, provides information about future data acquisitions and processing schedules, accepts and forwards data acquisition requests and processing requests, and provides access to the system management and status information

3. METHODOLOGY

The interface requirements, data interfaces and data flows were examined in this analysis. The analyses were performed manually and supplemented with the Automated Requirements Database (ARDB) and the interface Analysis Database (IADB).

The analysis of the IRD's interface requirements followed the approach described in Section 3.2 of the ISVVP. The interface requirements were analyzed in three areas: 1) quiality, 2) testability, and 3) tracability. Quality evaluation included an analysis of each requirement in terms of accuracy, completeness, ambiguity, consistency, and flexibility. Interface conflicts were identified, and each requirement was evaluated for identification of a testable function and an associated acceptance criteria.

The methodology used in the interface data flow analysis was derived from Section 3.3 of the ISVVP. The main objectives of this analysis were to verify the content, completeness and consistency of the data flows described in the IRD. All data flows were examined to determine if each data flow is required, if all required data flows are present, and if all data flows are consistent with the functional and performance requirements for the interface. This analysis identified missing data items and data item inconsistencies between multiple source documents.

The IADB tool was used extensively in this interface analysis effort. Each of the IRD-defined interface participants (the to:/from: entities), data flow items, data item attributes, and source requirements were identified and separately entered into the IADB. Requirements links and interface-data item relationships then were defined, in order to best replicate the contents of the IRD. Specific data base queries were used to sort and report the data back to the analyst, who identified any inconsistencies, overlaps, and omissions in the interfaces and data flows.

4. FINDINGS

The key findings of the analysis are provided below, listed in order of importance.

- **The Interface Requirements Documents are not ready to support systems design**

The detailed analysis, presented in the appendices, revealed that there are many technical problems in the IRDs. While most of these problems are not severe by themselves, the number of problems uncovered indicates that there is much detail work to be done by the development teams before high quality ICDs can be derived from the IRDs. The IRDs have incomplete specification of data volumes, data rates, duty cycles, and related performance requirements. Performance requirements must be defined prior to making interface design trade offs. The ECS F&PR contains data volume information for many of the data flows, but it is based on an old system architecture. If this information is being maintained in the EOSDIS data model, it is not propagating to the IRDs.

- **A Project-wide Data Dictionary is needed**

A data dictionary is not being used by the developers of the IRDs to ensure consistent naming of data items and data flows. This becomes a problem when comparing the IRDs to external documents. When comparing documents, it is difficult to differentiate the real inconsistencies from the simple naming problems.

- **The RTM data base is not current**

The integrity of the RTM database is questionable. The RTM has no ECS-NSI IRD requirements and is missing 21 ECS-TRMM IRD requirements. The RTM contains four requirements that were deleted from the ECS-TRMM IRD prior to baselining. The ECS-NISS and ECS-SCF IRDs have parent requirements in the IRD traceability matrices that are not documented in the RTM. These RTM observations are based on the 6/15/95 version of RTM [Ref 20].

- **The ICD development schedule is not realistic**

The ICD development does not allow for the incorporation of changes resulting from the IRD updates. Many of the IRDs are still undergoing the ESDIS baselining process, and thus changes would not be available to propogate to the ICDs until they are approved at the IRD level.

- **Parent documents have not been baselined**

The ADD and GSAD are not baselined. Since these documents establish the top level architecture of the EGS and the EOSDIS, it is essential that they be baselined to formally establish a starting point for EOSDIS component development. Current development, including interface specification, has been proceeding at risk. Substantial changes to the ADD and GSAD before a baseline is established could lead to the need to drastically re-direct component development without the benefit of a formal CCB review.

- **The ECS - NSI Interface Requirements Document is improperly focused**

The ECS - NSI IRD emphasizes network management issues rather than functional and performance requirements. From a technical standpoint, the interface functional and perfomance requirements are insufficiently defined to allow the development of an ICD.

- **The ECS - NSI IRD has not been baselined.**

Development of this interface has been proceeding at risk. Substantial changes to the ECS - NSI IRD before a baseline is established could lead to the need to drastically re-direct interface development without the benefit of a formal CCB review.

- **The current IRDs do not support the decision to combine Ecom and ESN into EBnet**

The IRDs do not support the new network architecture changes. The decision to consolidate Ecom and ESN into EBnet has rendered some of the current IRDs out of date. This issue is currently under review by the Network Team, but if EBnet interface requirements are not solidified soon, development schedules will suffer.

- **There is not a standard format and content for Interface Requirements Documents**

The DID specified for IRDs (DID 219/SE1) is woefully inadequate. The developer is not following any other standard for IRD format and content, leading to widely varying presentation formats and levels of detail in the IRDs. This makes it difficult to review these documents and to check for consistent data descriptions when data flows traverse more than one interface.

Detailed findings for each interface are provided in the appendices. There is a separate appendix for each interface in this document. The appendices are orgainized as follows:

APPENDIX X: DETAILED ANALYSIS RESULTS FOR XX
X.1 INTERFACE REQUIREMENTS ANALYSIS
- X.1.1 Quality
- X.1.2 Testability
- X.1.3 Traceability
- X.1.4 Standards

X.2 INTERFACE DATA FLOW ANALYSIS
- X.2.1 Internal Consistency Analysis
- X.2.2 External Consistency Analysis
- X.2.3 Data Item Analysis

5. RECOMMENDATIONS

- **Establish a recovery plan for the test version IRDs**

We recommend that the development teams establish and submit for EOSDIS Project approval a recovery plan and schedule for correcting all the deficiencies reported in this analysis. The recovery plan should respond to each detailed finding and provide complete and accurate IRDs by the end of the Critical Design Review (CDR).

- **Establish an EOSDIS Project Data Dictionary**

We recommend that the EOSDIS systems engineer, supported by the developer systems engineering organizations, establish and maintain a project-wide data dictionary to eliminate the data naming consistency problems between project level documents. This would make technical reviews easier and more effective and reduce confusion in the developer organizations.

- **Correct the RTM data base deficiencies and review the process for maintaining the RTM data base**

The RTM should be updated to include the most recent requirements changes, and the errors identified in this report corrected. The process for maintaining the RTM data base should be reviewed to see if the reasons for these errors occurring are due to a weakness in the process or just plain human error. Since the RTM system is now the official source of traceability links, it is critical that the RTM be made current and that a baseline RTM be established. We recommend that RTM be updated to include adequate traceability for all the IRD requirements. We further recommend that the appendices containing trace tables not be deleted from the IRDs until the IRD requirements in RTM have been baselined and the RTM maintenance process has been reviewed.

- **Revise the ICD development schedule to allow necessary corrections made to the IRDs to be incorporated.**

The ICD development should be revised to allow for the incorporation of changes resulting from the IRD updates. Many of the IRDs are still undergoing the ESDIS baselining process, and thus changes would not be available to propogate to the ICDs until they are approved at the IRD level..

- **Baseline the EOSDIS Architecture Description Document and ESDIS Ground System Architecture Document**

The EOSDIS development schedule is too far along not to have the top level system descriptions agreed to yet. These documents need to be baselined so that top level changes can be properly controlled and managed, not to eliminate top level changes. It should be recognized, however, that the development risk and financial burden imposed by top level architecture changes increases in proportion to the time after the start date that these changes were made.

- **Re-write the ECS - NSI Interface Requirements Document to focus on technical issues**

Once a standard format and content for IRDs is established, the ECS - NSI IRD should be re-written in that format to be sure that all the technical issues necessary for ICD development have been addressed.

- **Baseline the ECS - NSI Interface Requirements Document**

This IRD needs to be baselined expeditiously to provide a stable document, allowing the developers sufficient time to develop the subsequent ICDs.

- **Revise the IRDs to support EBnet**

Ecom and NSI interface requirements need to be reviewed and combined into EBnet interface requirements. This also requires that EBnet IRDs be written. To attempt EBnet interface development with a patch-work of Ecom and ESN requirements is likely to increase developer confusion and technical risk.

- **Establish a standard format and content for IRDs and ICDs**

A standard format and content for IRDs and ICDs needs to be established by the EOSDIS systems engineer and followed by the developers to ensure complete and consistent specifications and design descriptions of EOSDIS interfaces. The standard format and content needs to be made contractually binding on the development organizations.

APPENDIX A: DETAILED ANALYSIS RESULTS FOR NISS

A.1 Interface Requirements Analysis

The NISS interfaces are fully defined in existing ICDs. The ECS-NISS IRD is intended only to reflect the understanding of the support that will be provided by the NISS to the ECS, not to levy additional requirements on them (even though the requirements text is still written with 'shall' language for NISS functions). The IRD also is not intended to provide design-level details for the interfaces or data flows. Given this background, the language of the requirements was evaluated for technical integrity in three areas: quality (accuracy, completeness, ambiguity, etc.), testability, and traceability. The citation of appropriate format, protocol, and security standards was assessed, as well.

A.1.1 Quality

No quality problems were noted for this IRD.

A.1.2 Testability

The general format and content of the functional requirements was found to be less precise and complete than is desirable for testing and verification purposes. Some of the errors noted, which by themselves probably would not result in inappropriate test designs, do affect the accuracy and testability of the requirements and do place on the testers the responsibility of making certain assumptions. The performance requirements cited are a major testability problem. Exhibit A-1 describes these problems.

Requirements	Problem Description	Impact Statement	Recommendation
NI-1000 NI-1010 NI-1030 NI-1060	These four performance requirements are not written for the interfaces addressed by this IRD, but rather for the ECS as a whole. The performance of these particular interfaces cannot be tested against any of these broad criteria.	Performance requirements are not identified for the specific functions of these interfaces. Allocation of performance criteria for interface testing is left to the discretion of the test conductor. These general ECS performance requirements will be untestable within the test cases specific to these interfaces.	Delete the four general ECS requirements, as they are not directly applicable to these interfaces. Derive specific performance requirements for the interfaces of this IRD and document them. If specific requirements are not to be allocated to these interfaces, state so. If such requirements are to be documented elsewhere, then cite that source.
Most	Each requirement specifies/ implies the functionality of two or more distinct interface entities. There is not a one-to-one mapping of each function to a single, testable requirement (e.g., "ECS shall send..." and "FDF shall receive...").	Interfaces will be tested based on the requirements documented in the IRDs. For clarity of test design, implementation, and evaluation, interface requirements should specify only one function each. With the current requirements language, if one function fails during testing it would necessitate the 'failure' of other functions that were grouped into the same reqmt.	Split all requirements, so that each addresses only one function (e.g., send, receive). Ensure that the sender/receiver and the data item(s) are complete and unambiguous..

EXHIBIT A-1: Testability Problems

A.1.3 Traceability

All interface requirements on the ECS design should be traceable to one or more Level 3 parent requirements, and this traceability should be documented within the RTM system. The traceability for the requirements of the ECS-NISS IRD, as documented within RTM [Ref 20], was analyzed, and discrepancies are noted in exhibit A-2.

Two requirements, NI-0140 and NI-0440, have no parent requirements listed in RTM. This is inconsistent with the traceability matrix in the IRD, which does list parent requirements. However, RTM is the official source of traceability links, and it must be modified to include adequate traceability for these two requirements. IV&V recommendations of additional parent requirements for several IRD requirements, which would strengthen their traceability, are given.

Requirement	F&PR Specification
NI-0010	Add EOC-4005
NI-0020	Add EOSD1502, EOC-4008
NI-0030	Add EOSD1502
NI-0120	Add EOC-2520
NI-0130	Add EOC-4060
NI-0140	Currently no parent requirements are cited in RTM
NI-0220	Add EOSD1502, EOC-4008
NI-0230	Add EOSD1502
NI-0310	Add EOSD0025
NI-0440	Currently no parent requirements are cited in RTM

EXHIBIT A-2: Traceability Changes

A.1.4 Standards

The IRD does not cite any formats or standards for the various data types, though some formats can be inferred from the requirements for specific data transport paths (e.g., Ecom). Instead, all details and mission-specific requirements have been deferred to ICDs and DMR documents. If specific standards are to be applied to any of these dataflows, or are required of the data transport paths, then those standards need to be in the IRD.

There are no references to security standards. Protections that are available or necessary for known critical data flows need to be specified. Some security levels are loosely implied by the specification of certain communications networks for data transport, but if other security standards are known to be required, those requirements should be put in the IRD.

A.2 Interface Data Flow Analysis

The interfacing components and the data items transferred between them are illustrated in the following data flow diagram (exhibit A-3), which was adapted from the IRD. Once identified, the interfaces were analyzed for consistency and completeness of interface definitions, data item names, input and output, and data flow attributes. The problems identified by this analysis are summarized in the following three sections.

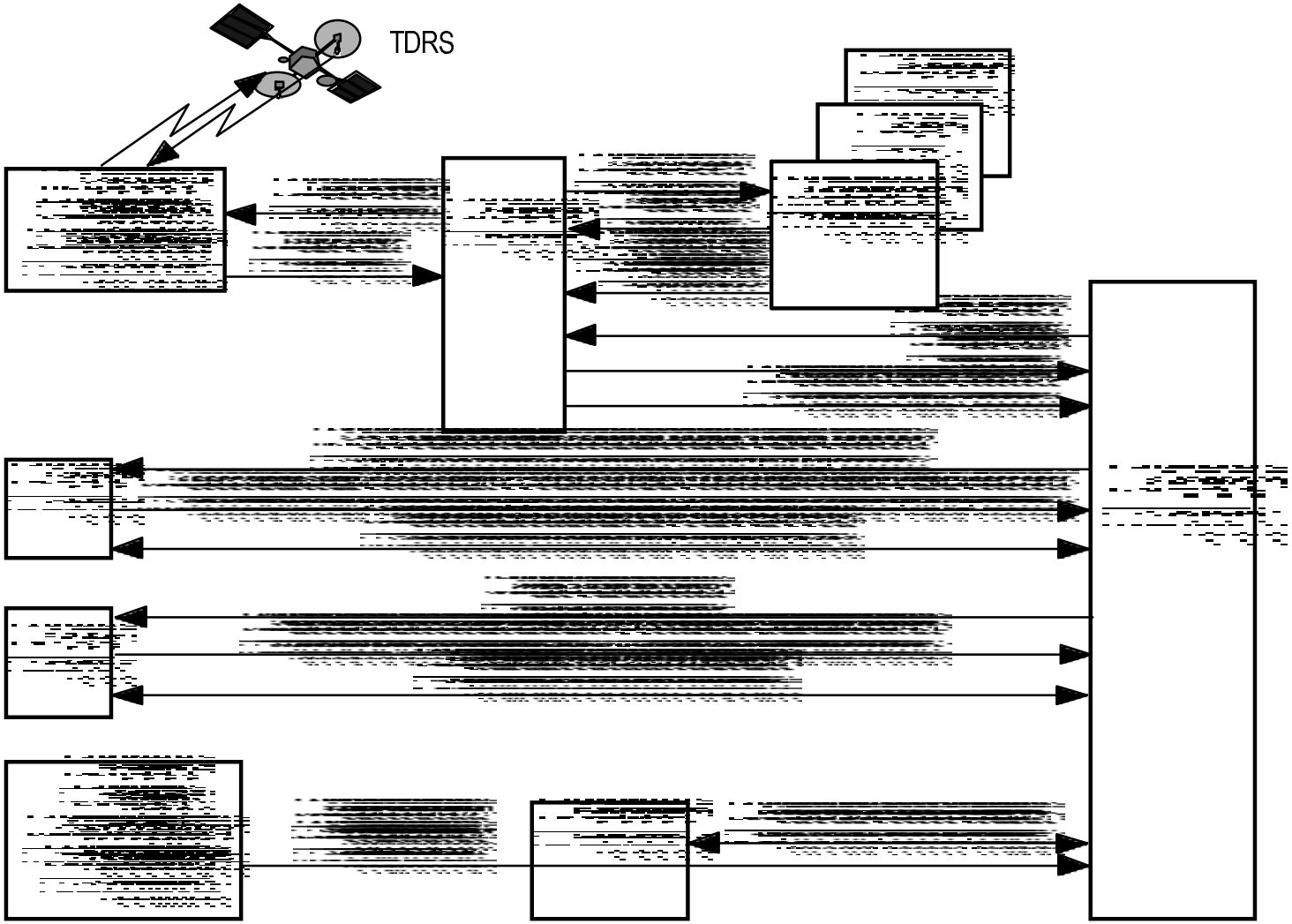

EXHIBIT A-3: ECS-NISS Interfaces

A.2.1 Internal Consistency Analysis

The internal consistency of interface descriptions, between the IRD's requirements text, interface diagram, and data flow table, was evaluated. Several discrepancies were found, however, specific recommendations are not being made for each of the problems.

For the ECS - TDRSS interface it is noted that the commands that are tranmitted are EOS spacecraft commands and not TRDSS commands, and simmilarly the telemetry is EOS spacecraft telemetry, and is transmitted via TDRSS and not from TDRSS. This fact is not entirely clear in the IRD.

For the ECS to TDRSS interface, there are variations in the way that intermediary systems are mentioned or depicted. The IRD's diagram shows EOS Data and Operations System (EDOS) as a sender and receiver of commands and telemetry data, while the data flow tables and requirements text state that the interface is across (not to/from) the EDOS interface. Exhibits A-4 and A-5 show the differences in interface participant designation. The role of EDOS as an interface participant should be represented clearly and consistently. In addition, the diagram only addresses the data flow on the ground; it does not show data flows up to the TDRSS or EOS spacecraft, as the requirements text describes.

IRD Diagram	IRD Data Flow Table	IRD Requirements
from ECS to EDOS: Commands *from EDOS to TDRSS Ground Terminals:* Commands	*from ECS (via EDOS to TDRSS):* Commands	*from ECS (via EDOS/Ecom interface) to TDRSS:* Commands

EXHIBIT A-4: ECS to TDRSS

IRD Diagram	IRD Data Flow Table	IRD Requirements
from TDRSS Gnd Terminals to EDOS: Telemetry *from EDOS to ECS:* Telemetry	*from TDRSS (via EDOS) to ECS:* Telemetry	*from TDRSS (via EDOS/Ecom interface) to ECS:* Return link (telemetry) data

EXHIBIT A-5: TDRSS to ECS

Between the ECS and the NCC, the interface is described fairly consistently, with similar data item and interface participant names (exhibits A-6 and A-7).

IRD Diagram	IRD Data Flow Table	IRD Requirements
from ECS: Non-telemetry Messages Schedule Coordination (DSN, GN, WOTS) TDRSS Schedule Requests	*from ECS:* Non-telemetry Messages Schedule Coordination TDRSS Schedule Requests	*from ECS:* Non-telemetry data messages Communicate to coordinate support... TDRSS schedule requests

EXHIBIT A-6: ECS to NCC Interface

IRD Diagram	IRD Data Flow Table	IRD Requirements
from NCC: Non-telemetry Messages Schedule Coordination (DSN, GN, WOTS) Schedule Result Messages TDRSS Schedule Messages	*from NCC:* Non-telemetry Messages Schedule Coordination Schedule Result Messages TDRSS Schedule Messages	*from NCC:* Non-telemetry data messages Communicate to coordinate support... Schedule Result Messages TDRSS Schedule Messages

EXHIBIT A-7: NCC to ECS Interface

For the interface between the ECS and the various ground tracking station networks, the data items specified to be sent across the interface are consistent within the IRD (exhibits A-8 and A-9). However, the path by which the data items travel is represented differently in each of the three parts of the IRD - the diagram shows the EDOS as an intermediate interface (sender and receiver) and the data flow table breaks the interface into three, one to each of the three ground station networks. The requirements text, in not making these distinctions, is less clear and less specific.

IRD Diagram	IRD Data Flow Table	IRD Requirements
from ECS to EDOS: Commands *from EDOS to GN/DSN/WOTS:* Commands	*from ECS to GN:* Commands *from ECS to DSN:* Commands *from ECS to WOTS:* Commands	*from ECS:* Commands

EXHIBIT A-8: ECS to GN/DSN/WOTS

IRD Diagram	IRD Data Flow Table	IRD Requirements
from GN/DSN/WOTS to EDOS: Telemetry Non-telemetry Messages *from EDOS to ECS:* Telemetry Non-telemetry Messages	*from GN:* Telemetry Non-telemetry Messages *from DSN:* Telemetry Non-telemetry Messages *from WOTS:* Telemetry Non-Telemetry Messages	*from GN/DSN/WOTS:* Return link (telemetry) data Non-telemetry data

EXHIBIT A-9: GN/DSN/WOTS to ECS

The IRD descriptions of the ECS to FDF interface and data items are fairly consistent, and where they do differ it is in the additional details provided in the requirements text (exhibits A-10 and A-11). Several of these data flows will change in the future, due to the recent shift in operational responsibilities between the EOS Operations Center (EOC)/ECS and the FDF, and it is expected that the same requirements level of detail will be maintained in any revised requirements language.

IRD Diagram	IRD Data Flow Table	IRD Requirements
from ECS: Orbit/Attitude Data Coordination Telemetry Subsets	*from ECS:* Orbit/Attitude Notification/ Request Telemetry Subsets	*from ECS:* Notification of orbit/attitude quality check Orbit/attitude data update request Telemetry stream subset

EXHIBIT A-10: ECS to FDF

IRD Diagram	IRD Data Flow Table	IRD Requirements
from FDF: Planning & Scheduling Info Command Info Orbit/Attitude Data Coordination Orbit/Attitude Data	*from FDF:* Planning Aids Command Info Orbit/Attitude Notification/ Coordination Orbit/Attitude Data	*from FDF:* Planning and scheduling info Parameters for command data generation Notification of orbit/attitude quality checks Orbit data & assoc. metadata Attitude data & assoc. metadata

EXHIBIT A-11: FDF to ECS

The IRD descriptions of the ECS - NOLAN interface and data items also are consistent, differing only in the additional details provided by the requirements text (exhibits A-12 and A-13).

IRD Diagram	IRD Data Flow Table	IRD Requirements
from ECS: Network Management Info	*from ECS:* Network Management Information	*from ECS:* Notifications of security breaches

EXHIBIT A-12: ECS to NOLAN

IRD Diagram	IRD Data Flow Table	IRD Requirements
from NOLAN: Network Management Info	*from NOLAN:* Network Management Information	*from NOLAN:* Notification of network faults Fault status information Estimated time to repair faults Summary information on faults Network performance and link utilization information Notifications of security breaches

EXHIBIT A-13: NOLAN to ECS

The descriptions of data items flowing across the NASA Data Processing Facilities (NDPF) to ECS interface are somewhat inconsistent, in that the requirement text specifies that orbit data will be sent to the ECS, while the data flow table uses 'etc.' to include that data item and all other as-yet-undefined data items. This inconsistency is not significant, since the requirement is written to be open-ended with respect to the list of data items received by the ECS.

IRD Diagram	**IRD Data Flow Table**	**IRD Requirements**
from NASA DPFs: Science Data Ancillary Data	*from NASA DPFs:* Science Data Ancillary Data etc.	*from NASA DPFs:* Science data Ancillary data Orbit data (at a minimum)

EXHIBIT A-14: NASA DPFs to ECS

A.2.2 External Consistency Analysis

Consistency between the IRD and other peer documents was difficult to verify, since the other institutional support requirements documents that were available are written at different levels of detail. The ECS-NISS IRD's descriptions of particular interfaces and data flows were compared, as appropriate, to the descriptions of the same interfaces in the ECS F&PR Specification [Ref 13] and in the DMR document for the AM-1 spacecraft [Ref 18].

The data flow descriptions for many of the interfaces are generally consistent, which was expected since many of the data items to be transferred across the interfaces are standard products (exhibit A-15). The F&PR Specification, being a higher-level document, does not always name the data items explicitly enough to

be used in this comparison. The lower-level DMR contains substantially more detail, including the more specific representation of the role of EDOS as an interface participant. In comparing the IRD to both of the other documents, the need to differentiate the role of the EDOS was made obvious. Even the more general F&PR Specification was more clear than the IRD requirements text on the role of the EDOS as a recipient/sender of particular data types. It is recommended that the IRD requirements concerning the need to communicate and send/receive data from the various satellite-tracking network ground facilities be made separate and distinct from the requirements to send and receive data via the EDOS.

A.2.3 Data Item Analysis

The ECS-NISS IRD is intended only to reflect the understanding of the support that will be provided by the NISS to the ECS, not to levy additional requirements on them (even though the requirements text is still written with 'shall' language for NISS functions). The IRD also is not intended to provide design-level details for the interfaces or data flows. The IRD does identify the data items to be transferred, and it does at times specify the physical communications link to be used for the data transfer. Other details are as described below.

No data volumes or rates (maximum or minimum) have been specified for the data flows in this IRD. All such details have been deferred to ICDs developed by the various institutional support systems and to the DMR documents for each EOS mission. Data volumes and rates should be noted for all significant data flows.

Data transfer frequencies have not been specified for the data flows. Certain NOLAN transmissions to the ECS are described as 'periodic', with no other clarification. Additional details have been deferred to ICDs developed by the various institutional support systems and to the DMR documents for each EOS mission. Without knowing the frequency of transmission of the data, it is not possible to determine minimal bandwidth requirements. Frequencies should be stated for all significant data flows.

No data archive durations or volumes have been specified. All such details have been deferred to ICDs developed by the various institutional support systems and to the DMR documents for each EOS mission. If there are data items which require archiving, this archiving information should be included in the requirements, so that no misunderstandings between the interfaces will develop.

	ECS-NISS IRD	F&PR Specification	DMR for AM-1
ECS to NCC	TDRSS schedule requests Non-telemetry data msg.	TDRSS schedule requests	TDRSS schedule requests Gnd control msg. requests User performance data Voice
NCC to ECS	TDRSS schedule msg. Schedule result msg. Non-telemetry data msg.	TDRSS schedules	Schedules TDRSS maneuver time pds. Time transfer msg. User performance data
ECS to FDF	Spacecraft telemetry subsets	Spacecraft housekeeping subsets	S/C orbit/attitude data Voice
FDF to ECS	Orbit data Attitude data S/C maneuver param. Planning/scheduling info Navigation ops param.	Post-pass ephemeris determination data Predicted orbit data	Orbit/attitude validation Predictive orbit ephemeris Navigation system param. Planning aids (various predictive data)
ECS to TDRSS	Commands		Commands
ECS to EDOS EDOS to TDRSS			CLTUs, Voice CLTUs
TDRSS to ECS	Telemetry		Telemetry
TDRSS to EDOS EDOS to ECS		-- Ancillary data Engineering data Housekeeping data	Telemetry (various) Spacecraft & instrument housekeeping data
ECS to GN/DSN/WOTS	Commands		Commands Voice
ECS to EDOS EDOS to GN/DSN/WPS			CLTUs, Voice Command data
GN/DSN/WOTS to ECS	Telemetry Non-telemetry data		Telemetry
GN/DSN/WPS to EDOS EDOS to ECS		-- Ancillary data Engineering data Housekeeping data	Telemetry (S-band) Housekeeping data --

Exhibit A-15: Consistency between Documents

APPENDIX B: DETAILED ANALYSIS RESULTS FOR NSI

B.1 Interface Requirements Analysis

The ECS - NSI IRD emphasizes network management issues rather than functional and performance requirements. From a technical standpoint, the interface functional and performance requirements are insufficiently defined to allow the development of an ICD. The interface requirements were evaluated for technical integrity in three areas: quality (accuracy, completeness, ambiguity, etc.), testability, and traceability. Problems were noted for a number of requirements in the areas of quality and testability. Certain traceability changes are suggested as well.

B.1.1 Quality

One ambiguous requirement was identified. Exhibit B-1 presents this problem.

Requirements	Problem Description	Impact Statement	Recommendation
NSI-0010	The phrasing "in order to provide access to DAAC's and EOSDIS data" is ambiguous. This phrase can be interpreted many ways. For example, the phrase could mean *physical access to the different DAACs, or access to the data generated by the DAACs*, etc..	Without a clear interpretation of the phrase, detailed data definitions can not be derived. This could cause problems when determining the bandwidth requirements of these circuits.	Reword the requireme to list specific data ite The "Communications Requirements Docume for the ECS Project" appears to take a shot defining and quantifyi some of these data flo and probably should b referenced within this document. The data flows documented in Table 4-1 should list specific data products

EXHIBIT B-1: Ambiguous Requirements

Exhibit B-2 presents the incomplete requirement problems.

Requirements	Problem Description	Impact Statement	Recommendation
NSI-0030 NSI-0040 NSI-0050 NSI-0060 NSI-0070 NSI-0080	The requirements state "The NSI shall ..." and "the ECS shall", it is not clear as to which specific NSI/ECS entities are responsible for sending/receiving the reports and notifications.	Failure to identify which specific entity is responsible for the reports/notifications could result in an incorrect implementation of the function, or the function not being implemented at all.	Identify the NSI/EC entities responsible each of the reports/notifications include this in table 1.
NSI-0070 NSI-0080	The term "NSI" does not fully identify the originator or recipient of the security breach	Failure to identify which NSI entity is responsible for the reports/notifications could result in an incorrect	In place of the term "NSI", identify the element as the NSI NOC, or more

	notifications.	implementation of the function, or the function not being implemented at all.	precisely, the "Computer Emerger Response Team (CERT)" as specifie in section 4.3.3, Security Manageme This change should also be made within Table 4-1.
NSI-0040	The requirement states "NSI shall make available to ECS ...". This terminology does not provide the method used to exchange the information (e.g. electronic, manual , etc.).	This requirement is open for interpretation, it is not clear how the information should be exchanged, will it be electronic, via E-mail, or verbally over the telephone. Failure to specify could result in incompatible designs between NSI and ECS.	Specify how the information is to be exchanged, so that proper design and functionality can be implemented.

EXHIBIT B-2: Incomplete Requirements

B.1.2 Testability

The general format and differentiation of the functional requirements were found to be less precise and complete than is desirable for testing and verification purposes. The errors noted, which by themselves probably would not result in inappropriate test designs, do affect the accuracy and testability of the requirements and do place on the testers the responsibility of making certain assumptions. The problems noted are presented in exhibit B-3.

Requirements	Problem Description	Impact Statement	Recommendation
NSI-0030 NSI-0040 NSI-0050 NSI-0060 NSI-0070 NSI-0080	Each requirement specifies/implies the functionality of two or more distinct interface entities. There is not a one-to-one mapping of each function to a single, testable requirement (e.g., "ECS shall send..." and "NSI shall receive...").	Interfaces will be tested based on the requirements documented in the IRDs. For clarity of test design, implementation, and evaluation, interface requirements should specify only one function each. With the current requirements language, if one function fails during testing it would necessitate the 'failure' of any other functions that were grouped into the same requirement.	Split all requirements, that each addresses on one function (e.g., sen receive). Ensure that sender/receiver and th data item(s) are comp and unambiguous..

EXHIBIT B-3: Testability Problems

B.1.3 Traceability

All interface requirements on the ECS design should be traceable to one or more Level 3 parent requirements. The traceability of each of the ECS-NSI IRD requirements to Level 3 requirements in the ECS F&PR Specification should be documented in the RTM system. However, the RTM contained no traceability for this IRD. The traceability analysis was performed using Appendix A, Requirements Traceability, in the ECS - NSI IRD. Exhibit B-4 summarizes recommended traceability changes.

Requirement	F&PR Specification
NSI-0010	Add ESN-118O
NSI-0060	Linkage to EOSDIS-3298 is questionable since this requirement seems to be geared towards expandability of network hardware

EXHIBIT B-4: Traceability Changes

B.1.4 Standards

The IRD does not cite any formats or standards for the various data types, though some formats can be inferred from the requirements for specific data transport media. NSI-0020 states that the "NSI shall provide support for Transmission Control Protocol/Internet Protocol (TCP/IP) communication protocols and services to ESN", but there are no requirements for the data transport between the NSI and ECS. Instead, all details and mission-specific requirements have been deferred to ICDs entitled ECS-NSI ICD. If standard formats or protocols are required, then they should be stated in the IRD. If standards are to be derived, then placing them in the ICDs is acceptable.

NSI-0070 and NSI-0080 address the sending and receiving between ECS and NSI of notifications of security breaches at NSI sites, within the NSI, or at ECS facilities, but fail to specify the types of security measures that will be taken to prevent security breaches. Section 4.3.3 of the IRD states that NASA requires NSI to implement security practices in accordance with accepted federal mandates and provides a list of reference documents. It is recommended that these requirements be added to the IRD as they pertain to the ECS - NSI interface.

B.2 Interface Data Flow Analysis

The interface participants and the data items transferred between them are illustrated in the data flow diagram (exhibit B-5), which was adapted from the IRD. Once identified, the interfaces were analyzed for consistency and completeness of interface definitions, data item names, inputs and outputs, and data flow attributes. The problems identified during this portion of the analysis are presented in the following sections.

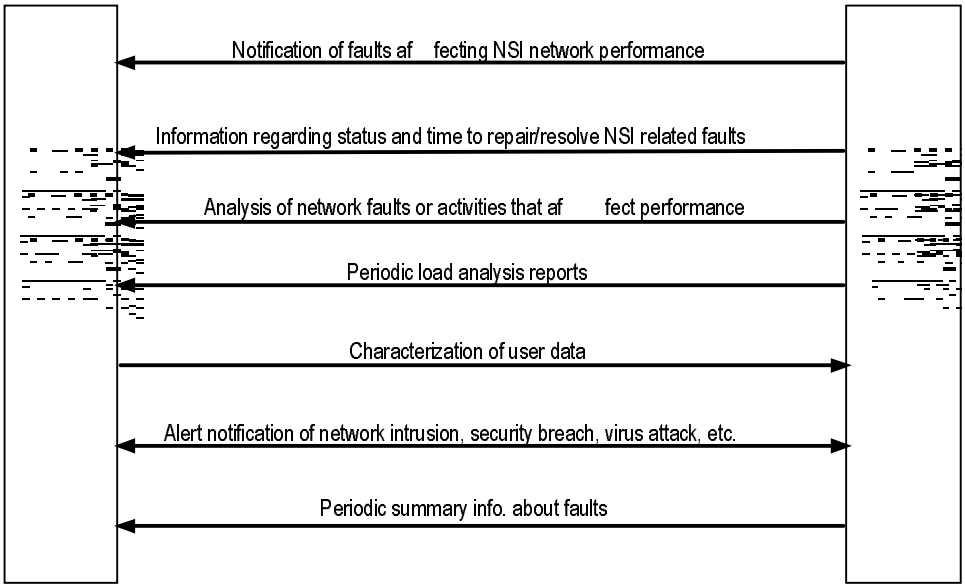

EXHIBIT B-5: ECS - NSI Data Flows

B.2.1 Internal Consistency

Three major consistency problems were found within this IRD. One major problem concerns the number of interfaces. The data flow diagram shows two interfaces, the requirements have four, while the data flow chart contains eight. This is primarily due to a higher level of detail being presented in the data flow chart than in the requirements or diagram. A second major problem is inconsistent usage of terminology. These inconsistencies make it difficult for the reader to determine if all data items presented in the diagram and chart correspond to numbered requirements. A third major problem concerns data items in the data flow chart and diagram not having corresponding numbered requirements. One example is the "characterization of user data" which is in the diagram and chart, but does not have a corresponding requirement. It is recommended that all internal document inconsistencies be corrected prior to baselining this IRD and the formulation of the ECS-NSI ICD.

From ECS To NSI

The IRD is not consistent in the naming convention of components and data items. The requirements and the diagram refer to the ECS to NSI Interface, while the data flow chart breaks this interface into two separate interfaces, Local Network Management Facility (LNMF) to NSI-NOC and Network Management Facility (NMF) to NSI-NOC. Also, the diagram includes characterization of user data, but this data item is not tied to a numbered requirement. It is recommended that a requirement be added to specify this data flow. Exhibit B-6 summarizes the ECS to NSI data flows.

IRD Diagram	IRD Data flow Chart	IRD Requirements
Characterization of User Data Network Alert	*LNMF to NSI-NOC* Network Security - Intrusion Detection *NMF to NSI-NOC*	Security Breach Notices

Notifications	Network Security - Intrusion Detection Performance Management	

EXHIBIT B-6: ECS to NSI Data Types

From NSI To ECS

The IRD is not consistent in the naming convention of components and data items. The data flow diagram refers to the ECS to NSI Interface, the requirements refer to the NSI to ECS and NSI to ECS-NMF, while the data flow chart breaks this interface into four separate interfaces, NSI-NOC to LNMF, NSI to LNMF, NSI-NOC to NMF and the NSI to NMF. Exhibit B-7 summarizes the NSI to ECS data flows.

IRD Diagram	IRD Data flow Chart	IRD Requirements
NSI to ECS Network Alert Notification Network Fault Analysis Network Fault Notification Network Fault Status Network Fault Summary Inf. Network Fault Time to Repair Network load analysis reports	*NSI-NOC to LNMF* Fault Notification *NSI- to -LNMF* Fault Resolution Network Security - Intrusion Detection *NSI-NOC to NMF* Fault Notification *NSI to NMF* Fault Resolution Network Security - Intrusion Detection Performance Management	*NSI to ECS* Network Fault Notification Network Fault Status Periodic Summary Inf.. Network Fault Time to Repair Security Breach Notices *NSI to ECS-NMF* Network performance/link utilization inf.

EXHIBIT B-7: NSI to ECS Data Types

From NSI To ESN Network Services

The NSI to ESN Network Services interface addresses only in the requirements and the data flow chart. Exhibit B-8 summarizes these data flows.

IRD Diagram	IRD Data flow Chart	IRD Requirements
---	*NSI - User* Data	DAAC Data EOSDIS Data

EXHIBIT B-8: NSI to ESN Network Services Data Types

From User To DAAC

The interface between the Users and the DAACs are represented only in the data flow chart. The requirements and the diagram make no reference to this interface. These data items do not have corresponding numbered requirements. It is recommended that appropriate requirements be added. Exhibit B-9 summarizes these data flows.

IRD Diagram	IRD Data flow Chart	IRD Requirements
---	Requests Searches	---

EXHIBIT B-9: USERS to DAAC Data Types

B.2. 2 External Consistency

Consistency between the IRD and other peer documents was difficult to verify, since the other communications requirements documents that are available were written at different levels of detail. The ECS-NSI IRD's descriptions of particular interfaces and data flows were compared, as appropriate, to the descriptions of the same interfaces in the ECS F&PR Specification [Ref 13], the Communications Requirements for the ECS Project [Ref 15], and the draft version of the ESDIS Project - NSI Project IRD [Ref 19].

The F&PR Specification, being a higher-level document, does not explicitly address interfaces between the ECS and NSI, the implied ECS - NSI data flows were found to be consistent with the IRD. The Communications Requirements for the ECS Project addresses the interface in a relaxed fashion, specific to and from data flows were not presented. The data flows between the ECS and the NSI NOC are described as information transmitted to enable network communications and network management. This information is further broken down into data to cooperatively provide services such as fault management, security management, and performance management. Although the data flows are non-descriptive, they are consistent with the ECS - NSI IRD. The draft version of the ESDIS - NSI IRD contained only brief descriptions of the NSI interfaces, no numbered requirements were included. However, the limited analysis performed did not show any major discrepancies among the interfaces.

B.2.3 Data Item Analysis

Information pertaining to data volumes and data rates is deferred to the ECS - NSI ICD. Data volumes and rates should be noted for all significant data flows.

NSI-0050 and NSI-0060 refer to periodic reports but do not provide a reporting frequency - a reasonable time interval for reporting should be established. Without knowing the frequency of transmission of the data, it is not possible to determine minimal bandwidth requirements. Frequencies should be included in the ECS - NSI ICD for all significant data flows.

Many of the requirements state that information shall be made available but have no mention of archiving the information (i.e. for what period of time should the information remain available). If there are data items which require archiving, this archiving information should be included in the requirements, so that no misunderstandings between the interfaces will develop.

APPENDIX C: DETAILED ANALYSIS RESULTS FOR TRMM

The November 1994 version of this IRD was previously analyzed and the results documented in the TRMM Interface TAR. The results documented here represent the analysis performed on the February 1995 version of the IRD.

C.1 Interface Requirements Analysis

The interface requirements were evaluated for technical integrity in three areas: quality (accuracy, completeness, ambiguity, etc.), testability, and traceability. Major issues were noted for a number of requirements in the area of testability. Certain traceability changes are suggested as well.

C.1.1 Quality

One ambiguous problem was identified. The requirements effected by this problem are presented in exhibit C-1.

Requirements	Problem Description	Impact Statement	Recommendation
TRMM1090, TRMM1100, TRMM2090, TRMM2100	There is a standard statement in the Functional and Performance Requirements section of the IRD that states, " All requirements utilize electronic computer controlled processes unless otherwise specified." The listed requirements imply the notification, assessment and negotiations will be done via non-electronic methods.	Unclear terminology can cause non-uniform implementations of the requirement. The vague terminology used to specifiy the notification, assessment and negotiation methods could result in the implementation of an electronic interface which does not seem to be the intent of these requirements.	Change the wording of the requirement to reflect the method of notification, assessment and negotiation.

EXHIBIT C-1: Ambiguous Requirements

Exhibit C-2 presents the incomplete requirements.

Requirements	Problem Description	Impact Statement	Recommendation
TRMM1070, TRMM2070	The IRD states the ECS LaRC and MSFC DAACs will ensure data reception and validation. The requirement does not state what constitutes validation.	Without the additional information of the means of validation it would be difficult to ascertain that the data has been received properly.	Specify the means by which data is validated and the criteria as well.
TRMM1170	The requirement states, "Data collected and processed for CERES solar calibration shall be scheduled by human interaction." This requirement does not state the source and destination of the data nor does it state the type of data to be collected for calibration.	Without the information as to the type of data, the source and destination it would make it difficult to determine what needs to be scheduled.	Identify the data type that is to be collected for calibration and the source and destination of the data.

EXHIBIT C-2: Incomplete Requirements

C.1.2 Testability

Several requirements have been identified with testability problems. Exhibit C-3 presents the requirements with testability problems.

Requirements	Problem Description	Impact Statement	Recommendation
TRMM3100, TRMM4090, TRMM5020	These requirements contain multiple functions.	During testing if one function of the requirement fails the entire requirement must be marked as failed.	Rewrite the requirements to contain one function.

EXHIBIT C-3: Testability Problems

C.1.3 Traceability

The traceability of the TRMM requirements to Level 3 requirements in the ECS F&PR Specification is documented in the traceability matrix of the IRD and should be stored within the RTM system. However, the following problems were noted with the matrix and RTM [Ref 20]: (1) TRMM1020, TRMM2020, TRMM3020 and TRMM4020 have been removed from the IRD but remain in both the traceability matrix and the RTM. (2) TRMM1220, TRMM2210, TRMM3140, TRMM4120, TRMM4140, TRMM5080, TRMM5090, TRMM5110 and TRMM5120 remain in the RTM, even though they have been removed from the IRD. (3) TRMM3110 has IMS0880 cited as the parent requirement in the traceability matrix, but the RTM cites IMS10072 as the parent. Exhibit C-4 summarizes other traceability problems and recommended changes.

Requirements	Problem Description	Impact Statement	Recommendation
TRMM1030, TRMM1090, TRMM2030, TRMM2090	The parent requirement SDPS0020 consists of information on the data type that SDPS shall receive, not the quality of the data.	Citing an incorrect linkage can cause improper implementation of the requirement.	Change the parent from SDPS0020 to SDPS0050. This linkage refers to the quality checks and accounting of data.
TRMM1190, TRMM2180	The parent requirement DADS1450 does not make reference to receiving data.	Citing an incorrect linkage can cause improper implementation of the requirement.	Change the parent from DADS1450 to SDPS0020. This linkage refers to receiving data.
TRMM1195, TRMM2185	These new requirements have not been included in the traceability matrix of the IRD nor added to the RTM.	Without the IRD requirements and linkages, interfaces may not be implemented.	Add the requirements to the traceability matrix and the RTM. Use EOSD1505 as the parent requirement.
TRMM1200, TRMM2190	These requirements need another linkage added to improve the quality	Requirements with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add linkage EOSD1505 to the matrix.
TRMM1210, TRMM2200	The parent requirement EOC2010 which is associated with these IRD requirements does not make reference to definitive orbit data.	Improper linkage could lead to the inability to verify the reception of data.	Remove EOC2010 as a linkage and only list IMS0510 as the parent requirement.
TRMM1280, TRMM2270	The parent requirement IMS1130 does not reference simulated data.	Citing an incorrect linkage can cause improper implementation of the requirement.	Change the parent requirement from IMS1130 to EOSD1680.
TRMM3030, TRMM4010	These requirements deal with the reception of TRMM browse and standard products from TSDIS. They should cite EOSD1608 as a parent	Requirements with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add EOSD1608 as a parent requirement.

	requirement because it details the reception of data products from the Earth Probe Data Systems.		
TRMM3110	The parent requirement which is cited in the traceability matrix (IMS0880), is different from what is cited in the RTM (IMS1072).	Citing different linkages in different places can cause improper requirement implementation .	The two requirements that were cited are applicable to the IRD requirement. Add each requirement to the other's table.
TRMM4030, TRMM4040	These requirements deal with TRMM data being ingested for archival and distribution. They should cite EOSD1607 as a parent requirement because it details the archive and distribution of TRMM data.	Requirements with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add EOSD1607 as a parent requirement.
TRMM5040	This requirement deals with the capabilities of the ECS to archive and distribute TRMM data. It should cite EOSD1703 as a parent requirement because it details the support of the data archive/distribution function.	A requirement with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add EOSD1703 as a parent. It refers to data archive and distribution.
TRMM8030	This requirement deals with the development of overall test plans and procedures. It should cite EOSD0760 as a parent requirement because it deals with the support of end-to-end EOS system testing.	A requirement with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add EOSD0760 as a parent requirement.
TRMM8071, TRMM8080, TRMM8081	These requiremens deal with the ECS support of all dataflows and archival/distribution functionality for integration and test and TRMM mission simulations. They should cite EOSD0800 as a parent requirement because it details the ECS support of end-to-end test and verification activities for the EOS program.	Requirements with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add EOSD0800 as a parent requirement.
TRMM8090	This requirement deals with the archival and distribution of TRMM algorithms and documentation in support of test and integration of interfaces with TSDIS. It should cite ESN0080 as a parent requirement because it deals with the ESN internal	A requirement with weak linkages could cause the requirement to be deleted or improper implementation of the interface.	To strengthen the validity of the requirement, add ESN0080 as a parent requirement.

	communication links to selected Earth Probe Data Systems (Landsat 7 and TRMM.)		
TRMM8130, TRMM8160	These requirements are not in the traceability matrix or the RTM.	Without the IRD requirements and linkages, interfaces may go untested.	Add these IRD requirements to the traceability matrix and the RTM. Use EOSD0750 as the parent requirement.
TRMM8170, TRMM8180	These requirements are not in the traceability matrix or the RTM.	Without the IRD requirements and linkages, interfaces may go untested.	Add these IRD requirements to the traceability matrix and the RTM. Use EOSD0020 as the parent requirement.
TRMM8190	This requirement is not in the traceability matrix or the RTM.	Without the IRD requirements and linkages, interfaces may go untested.	Add this IRD requirement to the traceability matrix and the RTM. se EOSD0630 and ESN0080 as the parent requirements.

EXHIBIT C-4: Traceability Problems

C.1.4 Standards

Sensor Data Processing Facility (SDPF) defined-standards are mentioned in requirements TRMM1180 and TRMM2170. Requirement TRMM5010 states ECS shall ingest...in the ECS format. These standards and formats should be briefly defined within the IRD and/or the appropriate documentation should be referenced for more details.

Reference is made to standard information management functions within the requirement TRMM5060. Again, this should be officially defined within the IRD or reference the appropriate documentation for more detail.

The ECS - TRMM IRD does not contain any performance requirements. In order for the proper protocols to be selected, the details of data rates, frequency of transmissions and data volumes must be specified.

Requirements TRMM3120 and TRMM4110 states that communications between TSDIS and the MSFC/GSFC DAACs shall be provided by ESDIS. This requirement should be listed as a Network requirement because other requirements already list the data items that are to be transferred between the TSDIS-MSFC and TSDIS-GSFC interfaces.

There are no references to security standards in the ECS - TRMM IRD. Protections that are available or necessary on the actual data or the directories which contain the data need to be stated clearly in the requirements. The requirements for security on access to archived data should also be provided. If additional requirements for security are needed beyond what is provided by the communication network, those requirements should be placed in the IRD. This interface should be following the standard set forth in the NASA Automated Information Security Handbook [Ref 10].

C.2 Interface Data Flow Analysis

The interface participants and the data items transferred between them are illustrated in the data flow diagram (exhibit C-5), which was adapted from the IRD. Once identified, the interfaces were analyzed for consistency and completeness of interface definitions, data item names, inputs and outputs, and data flow attributes. The problems identified by this analysis are summarized in the following two sections.

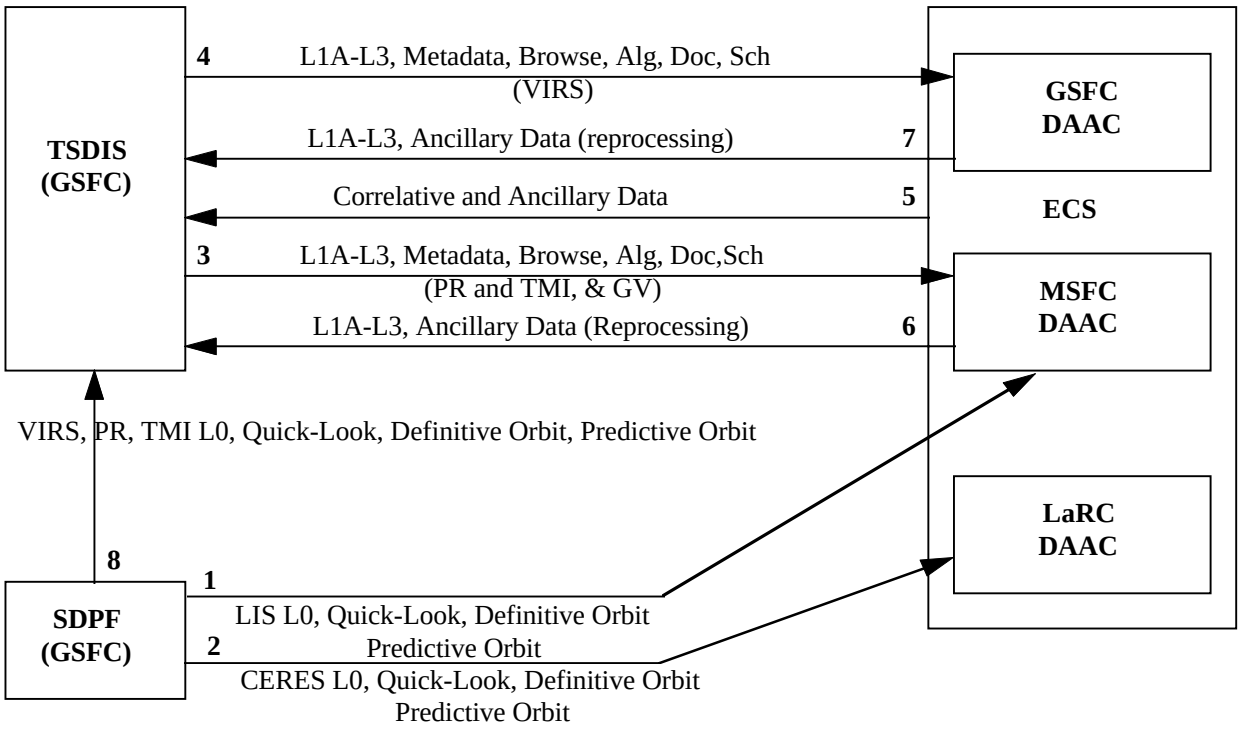

EXHIBIT C-5: TRMM-ECS Interface Diagram

C.2.1 Internal Consistency

The majority of the inconsistencies that were found in this phase of the analysis were internal to the IRD. Many inconsistencies were found between the IRD data flow chart, diagram and the requirements.

Several problems were encountered during this analysis which dealt with inconsistent use of terminology for data items and cases where data items do not exist in the IRD diagram, data flow chart or requirement sections. An example of data items with inconsistent naming conventions is in the use of "Level 0 data set" versus "Level 0 production data" in the SDPF to MSFC DAAC interface. An example of data items being internally inconsistent in the SDPF to LaRC DAAC interface, "Data Availability Notice" is only present for the IRD Requirements section. Another example of internal inconsistency is for GV data products. For the TSDIS to MSFC DAAC interface, GV data products are only listed in the requirements. For the MSFC to TSDIS interface, the GV data products are only

listed in the data flow chart. Also, the SDPF to ECS and TSDIS to ECS interfaces are missing from the data flow chart and diagram in the IRD.

The specific inconsistencies were not in themselves severe, however, inconsistent data definitions if left uncorrected, could lead to confusion during the development effort. The inconsistency of data items not existing in all three categories, could lead to improper implementation of requirements. The following sections detail the data items listed in each of the internal sections of the IRD.

SDPF to DAACs

Exhibits C-6 and C-7 lists the CERES and LIS data flow items for the SDPF to LaRC, MSFC and ECS DAAC interfaces. The IRD requirements list data availability notices that are sent to the DAACs. This information is not contained in any of the data flow charts or diagram [pages 3-2, 4-1] of the IRD.

IRD Diagram	IRD Data flow Chart	IRD Requirements
Level 0 data set	Level 0 data	Level 0 data set
Quick-Look	Quick Look data	Quick-Look
Definitive Orbit data	Definitive Orbit data	Definitive Orbit data
Predicted Orbit data	Predicted Orbit data	Predicted Orbit data
---	---	Data Availability Notice

EXHIBIT C-6: SDPF to LaRC and MSFC DAAC Data Flow Items

The SDPF to ECS interface does not exist in the diagram and data flow chart. Simulated data (TRMM1280 & TRMM2270), is the only data flow item listed in the IRD Requirements for this particular interface.

IRD Diagram	IRD Data flow Chart	IRD Requirements
---	---	Simulated data (CERES,LIS)

EXHIBIT C-7: SDPF to ECS Data Flow Items

TSDIS to DAACs

Exhibit C-8 through C-10 lists the data flow items for the TSDIS to GSFC, MSFC and ECS DAAC interfaces. The IRD requirements section of the TSDIS to GSFC DAAC does not list metadata and the diagram (Fig. 4-1), of the same interface does not list status information.

IRD Diagram	IRD Data flow Chart	IRD Requirements
Algorithms (VIRS)	Algorithms	Algorithms (VIRS)
Browse products (VIRS)	Browse data	Browse products (VIRS)
Data Availability Schedule (VIRS)	Data Availability Schedule	Product Availability Schedule
Documentation (VIRS)	Documentation	Documentation (VIRS)
Level 1A-3 data products (VIRS)	Level 1A-3 data products	Level 1A-3B data products (VIRS)
Metadata (VIRS)	Metadata	---
---	Status Information	Status Information

EXHIBIT C-8: TSDIS to GSFC DAAC Data Types

There is an additional listing of GV data products in the requirement TRMM3050, which does not exist in the IRD diagram and chart. Status information has not been included in the IRD diagram (Fig. 4-1).

IRD Diagram	IRD Data flow Chart	IRD Requirements
Algorithms (GV,PR,TMI)	Algorithms	Algorithms (PR,TMI)
Browse data (GV, PR, TMI)	Browse data	Browse data (GV, PR, TMI)
Data availability schedule (GV,PR,TMI)	Data availability schedule	Schedule of product availability
Documentation (GV,PR,TMI)	Documentation	Documentation (PR,TMI)
Level 1A-3B data products (GV,PR,TMI)	Level 1A-3 data products	Level 1A-3B data products (PR,TMI)
Metadata (GV,PR,TMI)	Metadata	Metadata (GV)
---	---	Data products (GV)
---	Status Information	Status Information

EXHIBIT C-9: TSDIS to MSFC DAAC Data Flow Items

The data flow chart (Table 3-1) and the diagram (Fig. 4-1), do not include the TSDIS to ECS interface as does the requirements in Section 5.5 of the IRD.

IRD Diagram	IRD Data flow Chart	IRD Requirements
---	---	Data availability schedule
---	---	Data product status

---	---	Level 1A-3 data products (standard products)
---	---	Metadata
---	---	Directory Information
---	---	Guide Information
---	---	Reprocessed Data
---	---	Standing Order
---	---	Browse Data

EXHIBIT C-10: TSDIS to ECS Data Flow Items
ECS to TSDIS

Exhibit C-11 lists the data types that were encountered for this particular interface. The IRD requirements is the only category that does not list correlative data. There is a listing of archived GV, PR, TMI and VIRS data in the IRD requirements(TRMM3100, TRMM4090), but there is no listing in the diagram or data flow chart.

IRD Diagram	IRD Data flow Chart	IRD Requirements
Ancillary Data	Ancillary Data	Archived ancillary data (GPI, NMC, SSM/I)
Correlative data	Correlative data	---
---	---	Archived data (GV, PR, TMI, VIRS)

EXHIBIT C-11: ECS to TSDIS DAAC Data Flow Items
DAACs to TSDIS

Minor problems found during the DAACs to TSDIS analysis are listed in Exhibits C-12 and C-13. The GSFC DAAC to TSDIS interface lists the data flow items Browse data, documentation, algorithms and metadata for the data flow chart [page 3-2], but they are non-existent in the IRD diagram. Another concern is the listing of VIRS Level 1A-3 data products for reprocessing in the IRD diagram [page 4-1, fig. 4-1], but it is listed as archived Level 1A-3 data products in the data flow chart[page 3-2]. The last problem is the only listing of a data flow item for the IRD Requirements occurs in TRMM4100, which is for a standing order.

IRD Diagram	IRD Data flow Chart	IRD Requirements
VIRS ancillary data (reprocessing)	Ancillary data	---
VIRS Level 1A-3 data products (reprocessing)	Archived Level 1A-3 data products	---
---	Browse data	---
---	Documentation	---
---	Algorithms	---
---	Metadata	---

---	---	Standing order

EXHIBIT C-12: GSFC DAAC to TSDIS Data Flow Items

The MSFC DAAC to TSDIS interface does not include browse data, documentation, metadata or algorithms in the diagram or requirements. The data flow chart includes an additional listing of GV data that is not found in the diagram or requirements.

IRD Diagram	IRD Data flow Chart	IRD Requirements
(GV,PR,TMI) Level 1A-3 data products (reprocessing)	Archived Level 1A-3 data products	PR, TMI, GV data products
---	GV data	---
Ancillary data (reproc.)	Ancillary data (SSM/I)	SSM/I data
---	Browse data	---
---	Documentation	---
---	Metadata	---
---	Algorithms	---

EXHIBIT C-13: MSFC DAAC to TSDIS Data Flow Items

SDPF to TSDIS

Exhibit C-14 lists the problems in the SDPF to TS
DIS interface. The IRD requirements do not include any data flow items for this interface.

IRD Diagram	IRD Data flow Chart	IRD Requirements
Definitive orbit data	Definitive orbit data	---
Predicted orbit data	Predicted orbit data	---
Level 0 data (PR, TMI, VIRS)	Level 0 data	---
Quick-Look data	Quick Look data	---

EXHIBIT C-14: SDPF to TSDIS Data Flow Items

DAACs to SDPF

Both the LaRC and MSFC DAACs to SDPF list one data flow items in the IRD requirements. This data item is not included in the diagram or the data flow chart.

IRD Diagram	IRD Data flow Chart	IRD Requirements
---	---	Acknowledgment of data reception

EXHIBIT C-15: LaRC and MSFC DAAC to SDPF Data Flow Items

C.2.2 External Consistency

The TSDIS System/Segment Design Specification [Ref 5], TSDIS Requirements Document [Ref 8], and the ECS F&PR Specification [Ref 13] were compared to the IRD for external consistency. There are many inconsistencies between documents. Both TSDIS documents do not list algorithms, data availability schedules, documentation, metadata or status information for the TSDIS to EOSDIS (DAACs) interface. The IRD does not list spacecraft housekeeping data and it does not break quick look data into three categories (scheduled, unscheduled and unscheduled normal operations quick look data), as the TSDIS documents do for the SDPF to TSDIS interface. The IRD does not list any individual GV sites or the GV to TSDIS interface as the TSDIS documents do. The IRD depicts that GV data will be received and distributed by certain DAACs. And last, none of the ancillary data listed in the IRD is listed in the TSDIS System/Segment Design Specification (GPI, GPCC and NMC).

C.2.3 Data Item Analysis

The data volume between ECS and TSDIS were examined for consistency. The TSDIS System/Segment Design Specification [Ref 5] and the TSDIS Requirements Document [Ref 8] were used as source documents for the TSDIS information. The ECS F&PR Specification [Ref 13] and the IRD were used as ECS source documents. Each of the interfaces between ECS and TSDIS were examined with respect to their data volumes and the detailed results are in exhibits C-16 - C-20. Inconsistencies between the documents concerning the data volumes were found. The following equations were used to obtain the values of the delta and delta percentages:

(1) TSDIS Requirement Document - ECS/TRMM IRD = Delta

(2) TSDIS Requirements Document / ECS-TRMM IRD * 100 - 100 = Delta Percentage.

The volumes for each of the data types leaving the TSDIS are listed in exhibit C-16 below.

Outgoing:	TSDIS System/ Segment Design Specification	TSDIS Requirements Document, Rev. 3	IRD Between The ECS and TRMM Ground System	F&P Requirements Specification For The ECS	Δ ECS vs. TRMM	Δ%
TSDIS to EOSDIS (Direct Processing)	14767 MB/day	20850 MB/day	14767 MB/day	15924 MB/day	6083	41
VIRS Level 1-3, Browse (to GSFC DAAC)	1409 MB/day	1420 MB/day	1409 MB/day		11	0
PR Level 1-3, Browse (to MSFC DAAC)	4364 MB/day	6445 MB/day	4364 MB/day		2081	47
TMI Level 1-3, Browse (to MSFC DAAC)	2350 MB/day	1316 MB/day	2350 MB/day		1034	44
GV Level 1-3, Browse (to MSFC DAAC)	5938 MB/day	6317 MB/day	5938 MB/day		379	6
Combined Products	707 MB/day	347 MB/day	707 MB/day		360	51
TSDIS to EOSDIS (Reprocessing)	29532 MB/day					
VIRS Level 1-3, Browse (to GSFC DAAC)	2817 MB/day		2800 MB/day			
PR Level 1-3, Browse (to MSFC DAAC)	8728 MB/day					
TMI Level 1-3, Browse (to MSFC DAAC)	4699 MB/day		26700 MB/day			
GV Level 1-3, Browse (to MSFC DAAC)	11875 MB/day					
Combined Products	1413 MB/day					

EXHIBIT C-16: TSDIS Outgoing Data Volumes

The volumes for each of the data types going into TSDIS are listed in exhibit C-17 below.

Incoming:	**TSDIS System/ Segment Design Specification**	**TSDIS Requirements Document, Rev. 3**	**IRD Between The ECS and TRMM Ground System**	**F&P Requirements Specification For The ECS**	**Δ ECS vs. TRMM**	**Δ %**
SDPF to TSDIS	2734 MB/day					
Definitive/Predictive Orbit Data	1 MB/day					
On-demand Quick Look Data	500 MB/day					
PR Level 0	967 MB/day	967 MB/day	967 MB/day		0	0
TMI Level 0	89 MB/day	63 MB/day	89 MB/day	1760 MB/day	26	29
VIRS Level 0	478 MB/day	495 MB/day	478 MB/day		17	3
Scheduled Quick Look Data	100 MB/day					
Spacecraft Housekeeping Data	100 MB/day					
Unscheduled Quick Look Data	500 MB/day					
Ground Validation to TSDIS (DDS-Direct Data Site) (DPS-Direct Processing Site)	2266(DDS) 4426(DPS) MBs/day					
Kwajalein (DDS)	206 MB/day	620 MB/day				
Guam (DDS)	1030 MB/day	620 MB/day				
Hawaii (DDS)	1030 MB/day	620 MB/day				
Darwin (DPS)	537 MB/day	551 MB/day				
Florida (DPS)	1626 MB/day	1719 MB/day				
Texas (DPS)	1397 MB/day	1101 MB/day				
Thailand (DPS)	308 MB/day	895 MB/day				
Taiwan (DPS)	308 MB/day	57 MB/day				
Israel (DPS)	125 MB/day	57 MB/day				
Sao Paolo (DPS)	125 MB/day	57 MB/day				
EOSDIS to TSDIS (Direct Processing)	40 MB/day					
Non-TRMM data (GPI, GPCC, NMC)	40 MB/day					
EOSDIS to TSDIS (Reprocessing)	10977 MB/day					
Combined Products	1390 MB/day					
GV Data(MSFC to)	1510 MB/day					
PR L1A Data(MSFC to)	2291 MB/day		1146 MB/day			
TMI L2A Data(MSFC to)	4219 MB/day		2110 MB/day			
VIRS L1B Data(GSFC to)	1487 MB/day		745 MB/day			
Non-TRMM Data (GPI, GPCC, NMC)	80 MB/day					

EXHIBIT C-17: TSDIS Incoming Data Volumes

The volumes for each of the data types exchanged with the SDPF are listed in exhibit C-18 below.

	TSDIS System/ Segment Design Specification	TSDIS Requirements Document, Rev. 3	IRD Between The ECS and TRMM Ground System	F&P Requirements Specification For The ECS	Δ ECS vs. TRMM	Δ %
SDPF to MSFC						
LIS Level 0			65 MB/day	65 MB/day		
SDPF to LaRC						
CERES Level 0			108 MB/day	216 MB/day		

EXHIBIT C-18: SDPF Data Volumes

No data rates for ground system transmissions have been specified in the IRD or in any of the supporting documentation. The TSDIS System/Segment Design Specification lists archival periods for operational storage and off-line storage, but the source and destination for the archival is not identified.

Exhibit C-19 below identifies the IRD as the only document which specified the frequency of transmissions, but the transmission rates were not specified for all data flow items.

Data Flow: Product	TSDIS System/ Segment Design Specification	TSDIS Requirements Document, Rev. 3	IRD Between The ECS and TRMM Ground System	F&P Requirements Specification For The ECS	Δ ECS vs. TRMM	Δ
SDPF to LaRC DAAC						
CERES Level 0 Data sets			1/day			
CERES Quick Look Data sets			3/day			
Notification of Availability			**			
SDPF to MSFC DAAC						
LIS Level 0 Data sets			1/day			
LIS Quick Look Data sets			3/day			
Notification of Availability			**			
MSFC to TSDIS						
TRMM PR, TMI, GV, and SSM/I Ancillary Data			**			
GSFC to TSDIS						
TRMM VIRS, AVHRR, GPI, GPCP, NMC Ancillary Data			**			

EXHIBIT C-19: Frequency of Product Transmissions

Each of the interfaces between ECS and TSDIS were examined with respect to the length of time which data is archived for each interface and the detailed results are in exhibit C-20 below. The IRD was the only document which specified which products were to be archived. However, several products were listed as archived products but the length of the archival period was not specified.

Location: Products	TSDIS System/ Segment Design Specification	TSDIS Requirements Document, Rev. 3	IRD Between The ECS and TRMM Ground System	F&P Requirements Specification For The ECS	Δ ECS vs. TRMM	Δ%
SDPF						
CERES Level 0 Data sets			5 days			
CERES Raw Data			730 days			
LIS Level 0 Data sets			5 days			
LIS Data			730 days			
ECS						
TRMM Standard Products			**			
Definitive Orbit Data			**			
LaRC DAAC						
CERES Standard Products			**			
MSFC DAAC						
LIS Standard Products			**			
PR, TMI, GV Data			**			
GSFC DAAC						
VIRS Data			**			

Exhibit C-20: Archived Data Products

** Denotes the data flow items that were listed , but the transmission rates and

APPENDIX D: DETAILED ANALYSIS RESULTS FOR SCF

D.1 Interface Requirements Analysis

The language of the requirements was evaluated for technical integrity in three areas: quality (ambiguity completeness accuracy, etc.), testability, and traceability. Major problems were noted for a number of requirements in the area of quality and testability. Certain traceability changes are suggested as well.

D.1.1 Quality

Exhibit D-1 presents ambiguous requirement problems. Several problems have been identified dealing with ambiguous requirements. The most significant of these problems was found in requirement SCF-0010. This requirement states that the SCF "computing platform" shall be "ESDIS approved", but does not specify what type of "computing platform" is likely to be "ESDIS-Approved.

Requirements	Problem Description	Impact Statement	Recommendation
SCF-0010	The requirement does not specify what type of "computing platform" is likely to be "ESDIS-Approved". The PGS Toolkit Requirements Specification (PGSTK-0101) provides more specific guidelines.	SCFs must know what type of computing platform to use. Failure to specify early could delay development or result in acquisition of a platform that fails to meet requirements.	Reword this requirement to indicate that "The SCF host shall consist of". Verify that platform requirements are specified in the Level 4 requirements / ICD.
SCF-0030	The requirement specifies the provision of "adequate" computing resources. The term adequate is not clear.	SCFs cannot implement vague requirements.	Specific requirements should be stated. Clarify the term "adequate".
SCF-0040 SCF-0050	These requirements imply that the ECS must be capable of sending a document (software specification requirements) to the SCFs. It is unclear whether this is a frequent exchange or a "one time only" manual transfer of information.	Failure to clearly define this "data flow" makes design of the interface difficult, and may lead to building unnecessary details into the system.	Verify that the "Data Production Software Specification Requirement" is a Document. Specify the frequency and mode of transmission
SCF-0070 SCF-0090 SCF-0350 SCF-0370	These requirements state that either the ECS or the SCF will "provide" a data item to the other. The term "provide" is not clear.	The ECS and SCFs cannot implement vague requirements.	Clarify the term "provide". Ensure that the frequency and mode of transmission are specified.
SCF-0100	The requirement specifies that the ECS shall "forward" Test Products to the SCF. A definition of the word "forward" is required	Failure to specify details of the data flow may lead to improper design of the interface.	Separate SCF-0100 into 2 requirements or delete SCF review portion of the requirement. Verify the acceptance criteria for SCF review of test products in the ICD and define method of transfer for test products
SCF-0130	The requirement states that Special Products "shall include L1 - L4 Special Products", but does not clearly limit "Special Products" to ONLY "L1 - L4 Special Products".	Failure to clearly specify the limitations on Special Products could lead to increased ECS processing and archival requirements.	Limit "Special Products" to ONLY "L1 - L4 Special Products".
SCF-0280	The requirement states that "the ECS shall have the capability to supply Reprocessing Status to the SCF." A definition of the word "supply" is required.	Failure to specify details of the data flow may lead to improper design of the interface.	Specify method of transfer, frequency, and process for initiating transfer.
SCF-0340	The requirement is not clear as to whether or not an SCF can request processing status on standard product generation. A definition of "SCF-requested data processing" is required.	Failure to specify details of the data flow may result may lead to improper design of the interface.	Clarify the term "SCF-requested data processing".

EXHIBIT D-1: Ambiguous Requirements

Exhibit D-2 presents the incomplete requirement problems. The most significant of these problems was found in requirement SCF-0001. This requirement states that "The SCF interface platform shall adhere to requirements specified in the Data Production Software and SCF Standards and Guidelines" but does not specify which portions of this document will apply to which functions of the interface.

Instead, this requirement serves only as a pointer to requirements in the SCF Standards and Guidelines document. These specific requirements must be included in the ECS <=> SCF IRD.

Requirements	Problem Description	Impact Statement	Recommendation
SCF-0001	The requirement serves only as a pointer to requirements in the SCF Standards and Guidelines document, and does not specify which portions of this document will apply to which functions of the interface.	Failure the specify which portions of the Standards and Guidelines document will apply to which functions of the interface may result in loss of functionality.	Specify which portions of the Standards and Guidelines document will apply to which functions of the interface. These specific requirements must be spelled out in the ECS <=> SCF IRD.
SCF-0070 SCF-0090	The method and frequency of exchange for Integration and Test Specifications, and the Data Production Software Delivery Package, are not specified.	Failure to include details from parent requirements in this requirement could result in loss of functionality.	Specify the frequency and mode of exchange for Integration and Test Specifications, and the Data Production Software Delivery Package.
N/A	Requirement ESN-1330 specifies that the ESN must provide ISO/OSI capabilities to external interfaces as required by the IRDs. This impacts the ECS-SCF interface, in that both the ECS and SCF must support these protocols and services.	Failure to define interface protocols and services make it impossible for SCF to build their side of the interface.	Add a requirement specifying that the SCF platform shall support ISO/OSI data communications protocols and services.
SCF-0040, SCF-0050, SCF-0070, SCF-0090, SCF-0100, SCF-0130, SCF-0140, SCF-0150, SCF-0160, SCF-0170, SCF-0180, SCF-0190, SCF-0280, SCF-0290, SCF-0330, SCF-0340, SCF-0350, SCF-0370	These requirements specify the ECS side of the interface only. The SCF side of these requirements is not provided.	Failure to define both sides of the interface (and make both sides sign up to the requirements) makes interoperability virtually impossible.	Add new requirements for the SCF side of these requirements.
Most	The requirements reference the ECS at too high of a level. The data flow diagram shows the SCF interfacing with specific segments of the ECS.	If the segments of the ECS that interface with the SCF's are not specified, this could result in incorrect implementation of the interface, or loss of functionality.	Specify in the IRD/ICD the segments of ECS that interface with the SCF's.

EXHIBIT D-2: Incomplete Requirements

Exhibit D-3 presents inaccurate requirement problems. Three requirements (SCF-0010, -0030, -0300) contain SCF functional requirements, not ECS - SCF interface requirements and should not be included in the ECS<=>SCF IRD. Another major inaccuracy, found in six requirements, is the limiting of data types to Special Products. The SCF may also produce or update the specified data types from Standard Products.

Requirements	Problem Description	Impact Statement	Recommendation
SCF-0010	The requirement states that "The SCF interface shall consist of..." but should read "The SCF interface platform shall consist of...".	As written, this requirement could result an incorrect implementation of the interface.	Reword the requirement to read "The SCF interface *platform* shall consist of...".
SCF-0010 SCF-0030 SCF-0300	This is an SCF functional requirement, not an ECS - SCF interface requirement	Functional capabilities could be missed at the SCF level.	Move this requirement to the SCF functional requirements document, or delete this requirement.
SCF-0140 SCF-0150 SCF-0160 SCF-0170 SCF-0180 SCF-0190	These requirements limit the parent requirement (DADS0190) to Special Products. The SCF may also produce or update data types from Standard Products.	Implementation of this requirement, as written, could result in a loss of functionality (i.e., no capability to produce or update Metadata from Standard Products).	Delete reference to Special Products from this requirement, or add additional requirements for standard products.

EXHIBIT D-3: Inaccurate Requirements

D.1.2 Testability

For clarity of test design, implementation, and evaluation, interface requirements should specify only one function each. Exhibit D-4 presents the testability problems. Requirement SCF-0001 has a testability problem due to the lack of specification of which portions of the standards and guidelines document will apply to which functions of the interface. With this essential information missing, interface acceptance criteria are undefinable. Requirements SCF-210, and SCF-240 place multiple functions within a single requirement.

Requirements	Problem Description	Impact Statement	Recommendation
SCF-0001	Since individual functionalities are not specified, testability becomes a problem. Will all of the requirements in the referenced document need to be tested to meet testing criteria for this requirement?	Unless it is specified which portions of the Standards and Guidelines document will apply to which functions of the interface acceptance criteria cannot be determined.	Specify which portions of the Standards and Guidelines document will apply to which functions of the interface. These specific requirements must be spelled out in the SCF ICD. At a minimum, the Data Production Software and SCF Standards and Guidelines, GSFC 423-16-01, must be agreed to by all SCFs and should be placed under configuration control
SCF-0210	This requirement contains 2 separate requirements.	If one function fails, all functions must be failed since they are all	This requirement should be broken into 2 individual

		in a single requirement.	requirements -- (1) The ECS shall have the capability to send a Data Quality Request Notification to the SCF. (2) This notification is sent when QA notification criteria are met during routine ECS processing.
SCF-0240	This requirement contains 3 separate requirements.	If one function fails, all functions must be failed since they are all in a single requirement.	Separate into 3 requirements -- (1) The ECS shall have the capability to receive an On Time QA from the SCF. (2) The ECS shall accept the On Time QA when it is received within the time-out period specified in the Data Quality Request Notification (3) The ECS shall accept post-time-out QA updates as Metadata Updates as specified by Requirements SCF-250.

EXHIBIT D-4: Testability Problems

D.1.3 Traceability

All interface requirements on the ECS design should be traceable to one or more Level 3 parent requirements. The traceability of each of the ECS<=>SCF IRD requirements to Level 3 requirements in the ECS F&PR Specification is documented and stored within the RTM system [Ref 20]. Exhibit D-5 presents the traceablity problems. Requirements SCF-0001 and SCF-0010 have no requirement link in RTM.

Requirements	Problem Description	Impact Statement	Recommendation
SCF-0001	No requirement link in RTM	Functional capabilities may be missed in ECS or SCF designs	Update the trace or delete the requirement.
SCF-0010	No requirement link in RTM	Functional capabilities may be missed in ECS or SCF designs	Add traceability to PGS-0602
SCF-0020	This requirement is incorrectly traced to PGS-0602, relating to compilers. Traceability for DCE clients and communications ports is missing.	Functional capabilities may be missed in ECS or SCF designs	Delete traceability to PGS-0602. Add traceability for DCE clients and communications ports
SCF-0030 SCF-0040	Incorrect traceability, DADS 0190 deals with the ECS receiving data from the SCF	Improper traceability may lead to improper design of the interface.	Remove the link to DADS-0190, identify correct link or delete requirement.
SCF-0050	Incorrect traceability, EOSD1750 deals with the ECS receiving data from the SCF, however Data Production Software Specifications are included.	Improper traceability may lead to improper design of the interface. not	Remove the link to EOSD1750. Identify correct link or delete requirement.

SCF-0070	Incorrect traceability, PGS-0640 deals with the ECS receiving data from the SCF	Improper traceability may lead to improper design of the interface.	Change, the requirement on the SCF to implement the Integration and Test Specifications in their Software Delivery Packages.
SCF-0110	Incorrect traceability, PGS-0640 deals with software, not reviewed test data.	Improper traceability may lead to improper design of the interface.	Remove the link to PGS-0640. Identify correct link or delete requirement.
SCF-0210	Incorrect traceability, PGS-0860 deals with algorithms and calibration coefficient testing, PGS-1130 deals with ECS receiving product QA.	Improper traceability may lead to improper design of the interface.	Remove the links to PGS-0860 and PGS-1130. Identify correct link or delete requirement.
SCF-0220	Incorrect traceability, PGS-1130 deals with product QA, not request for data to QA.	Improper traceability may lead to improper design of the interface.	Remove the link to PGS-1130. Identify correct link or delete requirement.
SCF-0230	Incorrect traceability, PGS-1130 deals with receiving QA'ed products from SCF, not sending data to the SCF to be QA'ed.	Improper traceability may lead to improper design of the interface.	Remove the link to PGS-1130. Identify correct link or delete requirement
SCF-0240	Incorrect traceability, SDPS0050 deals with archiving and distributing data products.	Improper traceability may lead to improper design of the interface.	Remove the link to PGS-1130. Identify correct link or delete requirement
SCF-0250	Incorrect traceability, PGS-1130 deals with receiving QA'ed products from SCF not metadata.	Improper traceability may lead to improper design of the interface.	Remove the link to PGS-1130. Identify correct link or delete requirement
SCF-0290	Incorrect traceability, EOSD0502 deals with software tools, and IMS-1440 deals with data base administration utilities, not the Local Data Access Services Delivery Package.	Improper traceability may lead to improper design of the interface.	Remove the links to EOSD0502 and IMS-1440. Identify correct link or delete requirement.
SCF-0300	Incorrect traceability, IMS-1400 deals with the process of data base importation into the ECS, not the COTS products that are required by Local Data Access Services.	Improper traceability may lead to improper design of the interface.	Remove the link to PGS-1130. Identify correct link or delete requirement
SCF-0310	Incorrect traceability, DADS2380 deals with sending calibration data to the SCF	Improper traceability may lead to improper design of the interface.	Remove the link to DADS2380. Identify correct link or delete requirement
SCF-0360 SCF-0370	Incorrect traceability, IMS-1660 is an ECS functional requirement and does not deals the interface. PGS-0650 deals with validating algorithm characteristics, not ECS resource usage.	Improper traceability may lead to improper design of the interface.	Remove the links to IMS-1660 and PGS-0650. Identify correct link or delete requirement

EXHIBIT D-5: Traceablity Problems

D.1.4 Standards

The IRD does not cite any formats or standards for the various data types. Instead, all details have been deferred to ICD.

The selection of interface protocols is an important design problem and the requirements should be clearly defined so as to facilitate this process. Data quality and performance requirements at each level in the International Standards Organization (ISO) model stack should provide information to aid the designer in protocol selection. SCF-0020 states that the, The SCF interface platform shall have the ability to run TCP/IP software for communication to the ECS, but it does not specify further requirements on frequencies or volumes. For these interfaces, details and mission-specific requirements have been deferred to ICDs and DMRs

There are no references to security standards in the ECS <=> SCF IRD. Protections that are available or necessary on the actual data or the directories which contain the data need to be stated clearly in the requirements. The requirements for security on archived data, and for access to archived data should be provided in the ECS F&PR. If additional requirements for security are needed beyond what is provided by the communication network, those requirements should be placed in the IRD. This interface should be following the standards set forth in the NASA Automated Information Security Handbook [Ref 10].

D.2 Interface Data Flow Analysis

The interface participants and the data items transferred between them are illustrated in exhibit D-6. Once identified, the interfaces were analyzed for consistency and completeness of interface definitions, data item names, input and output, and data flow attributes.

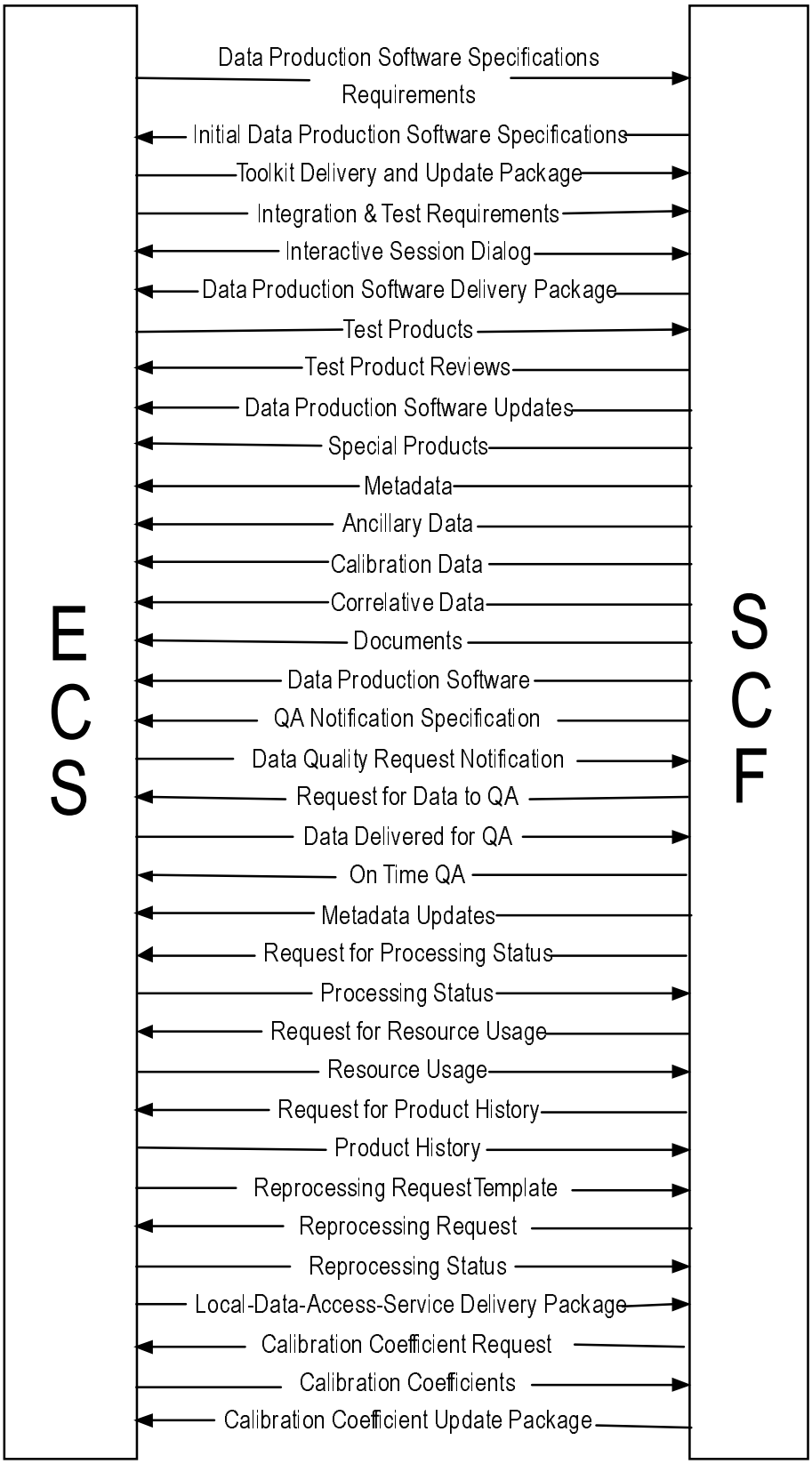
ECS
SCF
Data Production Software Specifications
Requirements
Initial Data Production Software Specifications
Toolkit Delivery and Update Package
Integration & Test Requirements
Interactive Session Dialog
Data Production Software Delivery Package
Test Products
Test Product Reviews
Data Production Software Updates
Special Products
Metadata
Ancillary Data
Calibration Data
Correlative Data
Documents
Data Production Software
QA Notification Specification
Data Quality Request Notification
Request for Data to QA
Data Delivered for QA
On Time QA
Metadata Updates
Request for Processing Status
Processing Status
Request for Resource Usage
Resource Usage
Request for Product History
Product History
Reprocessing Request Template
Reprocessing Request
Reprocessing Status
Local-Data-Access-Service Delivery Package
Calibration Coefficient Request
Calibration Coefficients
Calibration Coefficient Update Package

EXHIBIT D-6: ECS - SCF Data Flow Block Diagram

The IRD was analyzed for internal consistency within the document and external consistency with other peer documents.

D.2.1 Internal Consistency

The internal consistency of interface descriptions, between the IRD's requirements text, interface diagram, and data flow table, were evaluated. The discrepancies that were found are presented below.

IRD Diagram	IRD Data Flow Table	IRD Requirements
from ECS to SCF: Resource Usage Integration and Test Requirements Local Data Access Service Delivery Package	*from ECS to SCF:* Resource Usage Integration and Test Requirements Local Data Access Service Delivery Package	*from ECS to SCF* ECS Resource Usage Integration and Test Specification Local Data Access Services Delivery Package

EXHIBIT D-8: Internal Inconsistency

D.2.2 External Consistency

The ECS-SCF IRD's descriptions of particular interfaces and data flows were compared, as appropriate, to the descriptions of the same interfaces in the ECS F&PR Specification [Ref 13]. The F&PR Specification, being a higher-level document, does not explicitly address interfaces between the ECS and SCF, the implied ECS - SCF requirements were found to be consistent with the IRD.

D.2.3 Data Item Analysis

Data content and completeness problems were encountered while analyzing the IRD, the majority of these problems were minor, however, a few significant problems were encountered. These problems are contained in the paragraphs that follow.

There is no requirement in the IRD to document the contents of the Product Generation System (PGS) Toolkit. There is also no requirement placed on the SCFs to use the PGS Toolkit to develop software (requirement is part of toolkit specification). Failure to specify toolkit contents and delineate required/optional tools makes validation of this interface difficult.

Several SCFs will host Instrument Support Terminals (ISTs). The IST will be provided by ECS. The IST interfaces directly with the Flight Ops Segment (FOS) of the ECS, rather than the DAACs. Failure to include the IST requirements could lead to significant sizing and performance problems with the SCF -ECS interfaces, including failure to provide connectivity between sites.

There are no performance requirements given for this interface. . All performance requirements, data volumes, data rates, transmissions frequencies , archival period lengths are to be determined (TBD). Failure to specify performance requirements makes it difficult to verify the correctness of the interface. As ESDIS discovered in Version 0 (V0), failure to specify performance requirements leads to two

problems: (1) The interface is not designed for efficient performance. (2) Performance expectations exist (although not defined). Failure to meet these expectations leads to user dissatisfaction. The developers are then expected to raise performance. It is much easier to specify performance requirements prior to developing the interface.

APPENDIX E: REFERENCES

The following documents are referenced within this report:

1.	Interface Requirements Document Between EOSDIS Core System (ECS) and NISS	194-219-SE1-020	October 1994
2.	Interface Requirements Document Between EOSDIS Core System (ECS) and NASA Science Internet (NSI)	194-219-SE1-001	October 1994
3.	Interface Requirements Document Between EOSDIS Core System (ECS) and Science Computing Facilities	194-219-SE1-005	June 1994
4.	Interface Requirements Document Between EOSDIS Core System (ECS)) and the Tropical Rainfall Measuring Mission (TRMM) Ground System	194-219-SE1-018	February 1995
5.	TRMM Ground Segment Specifications	TSDIS-P300-VI	July 25, 1994
6.	TRMM Mission Specification	TRMM 490-001	July 1993
7.	TRMM Science Requirements		March 30, 1994
8.	TSDIS Requirements Document	TSDIS-P200-V3	June 20, 1994
9.	Memorandum of Understanding Between the Tropical Rainfall Measuring Mission (TRMM) Project and the EOS Ground System and Operations Project (GSOP) for Science Data Archive and Distribution Support	NASA/GSFC 423-10-04	October 1991
10	NASA Automated Information Security Handbook		
11	Independent System Verification and Validation Plan (ISVVP)	Deliverable 0302	October 17, 1994
12	EOSDIS Independent Verification and Validation Management Plan (IVVMP)	Deliverable 0301	August 15, 1994
13	Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System	NASA/GSFC 423-41-02	June 2, 1994
14	EOSDIS Core System (ECS) Preliminary Requirements Analysis Report	Deliverable 0502	October 28, 1994
15	Communications Requirements for the ECS Project	220-CD-001-003	February 1995
16	IST Capabilities Document for the ECS Project	194-00602TPW	November 1994
17	Data Production Software and Science Computing Facility (SCF) Standards and Guidelines	4223-16-01	January 14, 1994
18	Detailed Mission Requirements for AM-1		July 1994
19	Earth Science Data and Information System (ESDIS) Project - NASA Science Internet (NSI)	Draft Version	August 2, 1994

	Project Interface Requirements Document (IRD)	
20	RTM	June 15, 1995
21	EOS Ground System Architecture Description Document (ADD)	Draft Version March 10, 1995
22.	EOS Ground System Architecture Diagram (GSAD)	Preliminary Draft March 9, 1995